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HOUSE OF REPRESENTATIVES

REPORT
No. 98-73

AUTHORIZING APPROPRIATIONS TO THE NATIONAL SCIENCE FOUNDATION

APRIL 26, 1983.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

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Mr. FUQUA, from the Committee on Science and Technology, submitted the following

REPORT

together with

MINORITY VIEWS

[To accompany H.R. 2066]

[Including cost estimate of the Congressional Budget Office]

The Committee on Science and Technology, to whom was referred the bill (H.R. 2066) to authorize appropriations for the National Science Foundation for fiscal years 1984 and 1985, having considered the same, report favorably thereon with amendments and recommend that the bill as amended do pass.

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The amendments are as follows:

The title of the bill is amended to read: "To authorize appropriations to the National Science Foundation for fiscal year 1984".

Strike all after the enacting clause and insert in lieu thereof the following:

SEC. 2. (a) There is authorized to be appropriated to the National Science Foundation for the fiscal year 1984 the indicated sums in the following categories:

(1) Mathematical and Physical Sciences, $358,600,000.

(2) Engineering, $121,000,000.

(3) Biological, Behavioral, and Social Sciences, $236,400,000.

(4) Astronomical, Atmospheric, Earth, and Ocean Sciences, $329,800,000.

(5) Antarctic Research Programs, $102,100,000.

(6) Scientific, Technological, and International Affairs, $36,800,000.

(7) Program Development and Management, $66,000,000.

(8) Science and Engineering Education, $39,000,000.

(b) Of the sum of the amounts authorized under subsections (a)(1), (a)(2), and (a)(4), not less than 15 per centum shall be available for research instrumentation.

(c) In addition to the amounts authorized under paragraph (6) of subsection (a), an additional $23,200,000 shall be made available from the amount authorized under paragraphs (1), (2), (3), (4) and (7) of subsection (a) to the Directorate of Scientific, Technological, and International Affairs to be obligated under such paragraph (6).

(d) Of the amount authorized under subsection (a)(3), not less than $8,000,000 shall be available to the Information Science Division.

(e) In addition to the amount authorized under subsection (a), there is authorized to be appropriated to the National Science Foundation the sum of $50,000,000 for high technology instrumentation to be used for new research initiatives, new laboratory development, and technology for delivering instruction (including software costs and royalties when an integral part of such instruments). The Foundation is authorized to provide such arrangements as will facilitate user charges for private, public, or consortia-owned devices.

SEC. 3. Appropriations made under authority provided in sections 2 and 5 shall remain available for obligation or for obligation and expenditure for periods specified in the Acts making the appropriations.

SEC. 4. From appropriations made under authorizations provided in this Act, not more than $2,500 for fiscal year 1984 may be used for official consultation, representation, or other extraordinary expenses at the discretion of the Director of the National Science Foundation. His determination shall be final and conclusive upon the accounting officers of the Government.

SEC. 5. In addition to the sums authorized by section 2, not more than $3,000,000 for fiscal year 1984 is authorized to be appropriated for expenses of the National Science Foundation incurred outside the United States, to be drawn from foreign currencies that the Treasury Department determines to be excess to the normal requirements of the United States.

SEC. 6. If the total amount of appropriations made by any Act for fiscal year 1984 for program activities included in sections 2 and 5 is less than the total amount authorized to be appropriated for those activities by sections 2 and 5, the amount available from such appropriations for any particular program activity shall bear the same ratio to the amount authorized to be appropriated for that activity by sections 2 and 5 as the total amount of the appropriations made by such appropriation Act for all included program activities bears to the total amount authorized to be appropriated for those activities by sections 2 and 5 (with the minimum amount required by section 2(b) being reduced in the same ratio), except to the extent specifically otherwise provided in the text of the Act making the appropriations for the program activities involved.

SEC. 7. Funds may be transferred among the categories listed in section 2(a) so long as the net funds transferred to or from any category do not exceed 10 per centum of the amount authorized for that category in section 2. The Director of the Foundation may propose transfers to or from any category exceeding 10 per centum of the amounts authorized for that category in section 2. An explanation of any such proposed transfer shall be transmitted in writing to the Speaker of the House, the President of the Senate, the House Committee on Science and Technology, and the Senate Committee on Labor and Human Resources. The proposed transfer may be made only when thirty calendar days have passed, after the transmission of such explanation, without the Chairman of either such committee having notified the Director to the effect that the committee objects to the proposed transfer.

SEC. 8. (a) Section 9 of the National Science Foundation Act of 1950, as amended, is amended to read as follows:

That this Act may be cited as the "National Science Foundation Authorization Act for Fiscal Year 1984".

"SEC. 9. (a) Each special commission established under section 4(h) shall be appointed by the Board and shall consist of such members as the Board considers appropriate.

"(b) Special commissions may be established to study and make recommendations to the Foundation on issues relating to research and education in science and engineering."

(b) Section 6 of the National Science Foundation Authorization Act, Fiscal Year 1978 (Public Law 95–99), is repealed.

(c) Section 10 of the National Science Foundation Authorization Act, Fiscal Year 1978 (Public Law 95–99), is repealed.

(d) Section 12 of the National Science Foundation Act of 1950 is amended by striking out subsection (b) and by striking out "(a)".

I. SUMMARY

BUDGET ACTIONS

Budget total

The President's budget included a request for $1,292,300,000 for the National Science Foundation in fiscal year 1984.

H.R. 2066 includes new obligational authority totalling $1,342,700,000. This amount is a $50,400,000 increase over the Administration's request.

Increases

1. A new program to provide high technology instrumentation for new research initiatives, new laboratory development and technology for delivering instruction is authorized at $50 million.

2. Biological, Behavioral, and Social Sciences is increased by $12.8 million, to provide $15 million in additional funding for the social, behavioral and information sciences.

3. Funds for the Special Foreign Currencies account are increased by $400 thousand to provide monies to coordinate the new U.S./India cooperative program.

Decreases

1. The request for Mathematical and Physical Sciences is decreased by $5.7 million to $358.6 million, providing an increase over fiscal year 1983 of $58.9 million.

2. The request for Engineering is reduced by $2.0 million to $121 million, providing an increase over fiscal year 1983 of $20.2 million.

3. The request for Astronomical, Atmospheric, Earth and Ocean Sciences is decreased by $5.1 million to $329.8 million, providing an increase of $53.6 million over fiscal year 1983.

Other

1. The bill requires that of the amount authorized for Biological, Behavioral and Social Sciences, not less than $8 million shall be available for the Information Science and Technology Subactivity.

2. The bill requires that not less than 15 percent of the sum of the amounts authorized for Mathematical and Physical Sciences, Engineering, and Astronomical, Atmospheric, Earth and Ocean Sciences shall be used for research instrumentation.

3. The bill requires that of the amount authorized for Research and Related Activities exclusive of the amounts for Antarctic Research Programs, Scientific, Technological and International Affairs and High Technology Research Instrumentation, $23,200,000 be made available through reallocation for programs in the Directorate of Scientific, Technological, and International Affairs.

OTHER ACTIONS

A. The bill amends the National Science Foundation Act of 1950 to provide greater flexibility in establishing special commissions by the National Science Board and in providing membership for such commissions. The bill also repeals section 6 of Public Law 95–99 regarding National Resource Centers, the codification being considered as redundant and unnecessary.

B. Two additional amendments were made: (1) to repeal a disclosure provision contained in an earlier amendment to the National Science Foundation Organic Act which has been superseded by broader provisions and requirements of the Ethics in Government Act; (2) to repeal the National Science Foundation Act for fiscal year 1978 provisions banning NSF employees from owning patents on inventions resulting from NSF work. NSF does no in-house research and the provisions have never been needed.

C. Additional concerns and views of the Committee are reflected in the sections of this report on views and programs.

PURPOSE OF THE BILL

The purpose of the bill is to authorize appropriations to the National Science Foundation for fiscal year 1984 in the amount of $1,339,700,000 out of money in the Treasury not otherwise appropriated and $3,000,000 for fiscal year 1984 in foreign currency which the Treasury Department determines to be excess to normal requirements of the United States as follows:

Budget activities	*Authorization fiscal year 1984*
Research and related activities:	
Mathematical and physical sciences	$358,600,000
Engineering	121,000,000
Biological, behavioral and social sciences	236,400,000
Astronomical, atmospheric, Earth and ocean sciences	329,800,000
U.S. Antarctic program	102,100,000
Scientific, technological and international affairs	36,800,000
Program development and management	66,000,000
High technology research instrumentation	50,000,000
Special foreign currency	3,000,000
Science and engineering education	39,000,000
Total	1,342,700,000

NATIONAL SCIENCE FOUNDATION BUDGET COMPARISONS—ACTIONS BY THE COMMITTEE ON SCIENCE AND TECHNOLOGY

[Authorizations in millions of dollars]

Activities	Current fiscal year 1983	Administration request fiscal year 1984	Committee recommendation (H.R. 2066)	Changes from administration proposal
Mathematical and physical sciences	$299.7	$364.3	$358.6	−$5.7
Engineering	100.8	123.0	121.0	−2.0
Biological, behavioral, and social sciences	190.2	223.6	236.4	+12.8
Astronomical, atmospheric, Earth, and ocean sciences	276.2	334.9	329.8	−5.1
U.S. Antarctic program	83.2	102.1	102.1	0
Scientific, technological, and international affairs	44.2	36.8	36.8	0
Research instrumentation initiative	0	0	50.0	+50.0
Program development and management	65.3	66.0	66.0	0
Undistributed	4.5	.0	0	0
Subtotal, research and related activities	1,064.1	1,250.7	1,300.7	+50.0
Science and engineering education	30.0	39.0	39.0	0
Special foreign currency	3.1	2.6	3.0	+0.4
Total	1,097.2	1,292.3	1,342.7	+50.4

II. Committee Views

I. SCIENCE AND ENGINEERING EDUCATION

Committee view

The Committee continues to feel strongly that the Foundation should maintain a strong and decisive role in science and engineering education. Whereas the Committee favorably views the increased emphasis on science and math education as indicated by the Administration, the Committee believes the budget request falls far short of the nation's present educational needs. It is for this reason and others that the Committee reported favorably H.R. 1310, the recent emergency legislation in science and math education which will begin to deal with this complex issue. It is the Committee's view that the additional $130.0 million authorized in H.R. 1310 for NSF for Summer Institutes and Workshops, Post-Secondary Faculty Development, Educational Research and the special cost-sharing, Engineering and Science Personnel Fund complement the graduate fellowships and pre-college teaching programs as provided in the Administration's $39.0 million request for education at the Foundation. The Committee intends that, between H.R. 1310 and this authorization, the Foundation shall have $169.0 million for Science and Engineering Education.

Discussion

The National Science Foundation, since its inception has had broad responsibilities in science and mathematics education at all levels in the precollege school system. In August, 1981, the National Science Board reaffirmed the position of the Foundation in a statement on these activities (NSB–81–324) which noted that the Foundation has specific responsibility under the National Science Foundation Act to "recommend and encourage . . . national poli-

cies for the promotion of . . . education in the sciences" and "to initiate and support . . . programs to strengthen . . . science education . . . at all levels". Thus, the Foundation should be expected to play a key role in the nation's effort to restore the scientific literacy of the citizenry and to renew the pool of technically trained manpower so badly needed to maintain U.S. competitiveness and security into the 21st century.

Following the launching of Sputnik by the U.S.S.R., the U.S. embarked on major programs to upgrade the nation's abilities in the technical fields. Unfortunately, this effort was not sustained and, due to a complex variety of causes, the United States has seen a steady decline in the last decade in the scientific literacy and technical capabilities of its population. Hearings before this Committee's Subcommittee on Science, Research and Technology have strongly documented the problem which extends from our elementary schools through our universities. Declining student capabilities in math and science, severe shortages of qualified mathematics and science teachers in the school system, and in qualified faculty at universities and colleges all indicated to the U.S. Congress that immediate action was required.

H.R. 1310, passed by the House of Representatives on March 2, 1983, represents a first effort in the Congress to reverse the trend described above. The bill assigns a variety of responsibilities to the Foundation. The NSF will be responsible for supporting jointly with the Department of Education summer institutes and other workshops for teachers and supervisors in elementary and secondary schools; supporting through grants a program for undergraduate mathematics, science, and critical foreign language curriculum development and faculty development; investigating methods to increase the effectiveness of educational programs; and administering Title II of the bill, the National Engineering and Science Personnel Act. Title II is a matching grant program which will enable the Foundation to address problems such as engineering and science faculty recruitment and retention, equipment and instructional material acquisition and dissemination in our nation's two year and community colleges, four year colleges, and research universities, as well as public understanding of science and mathematics.

H.R. 1310 thus assigns to the Foundation, along with the Department of Education, major responsibilities in upgrading the technical capabilities of the nation. Certainly the House and this Committee expect the Foundation to do more than traditional curriculum development programs in science and mathematics on which the Foundation has done such an excellent job in the past. The Committee views the Department of Education and the National Science Foundation as cooperating agencies each with their own unique strengths and capabilities which they can bring to bear on the problem.

The educational activities proposed by the Foundation for fiscal year 1984 should be seen, then, in light of the Committee's view of the Foundation's total capabilities. The Foundation should not restrict its activities to curriculum development, but also should proceed to support workshops and training activities in cooperation with state and local governments and/or the private sector as pro-

posed in its FY 1984 budget request. In the Committee's view, this program should not be limited to secondary teachers but should be roughly divided equally between secondary and elementary teacher activities. The Committee is concerned that the one-to-one matching requirement for the science and mathematics teaching improvement program will discriminate against the nation's poorer school districts, both in rural and in inner-city areas. In the Committee's view, school districts should be eligible to compete for some funds without requiring a matching requirement. Additional funds might then be provided on a matching basis. The Committee notes that the Foundation has, in fact, chosen to use this procedure with the Presidential Young Investigators Awards Program. In this program an initial award of $25,000 can be supplemented with another $37,500 of Federal funds on a one-to-one matching basis. The Committee sees no reason why a similar program would not be suitable for the precollege program effort. The Committee further believes that the proposed focus on precollege science teacher excellence through the Presidential Awards for Teaching Excellence program is an appropriate Foundation activity to provide needed incentives for excellence in precollege science and math teaching.

The Committee commends the Foundation's efforts to focus on young science and engineering faculty through its proposed Presidential Young Investigator Awards program. The Committee notes that this new proposal has an excellent model in the ongoing Engineering Research Initiation Grants (RIGS) program within the Engineering Directorate. As discussed in the next section of this report the Committee believes that the new awards program should allow eligibility for researchers in *all* fields of science and engineering, and not just limited to the fields of engineering and the physical sciences.

The Committee strongly supports the increase in the stipend for Graduate Research Fellowships as being necessary to attract the best talent to our nation's research universities and eventually, it is hoped, a teaching and research career.

Quality undergraduate instruction in science, mathematics, engineering and related technology development is essential to the economic productivity and security of the nation. The undergraduate programs of our colleges and universities are the source of our graduate students, faculty, and Ph.D. scientists and engineers. The general undergraduate student population also receives instruction in these fields. The quality of that instruction shapes in important ways the general science literacy and related capabilities of the nation.

The widespread concern for the health of precollege science and mathematics education and the steps now being taken to address those pressing needs do not address the requirements to strengthen the nation's undergraduate programs. The Committee is pursuaded by the evidence presented to it that our undergraduate instructional programs also must be strengthened and equipped to meet the nation's requirements. The Committee will address the needs of undergraduate programs more directly next year.

2. BEHAVIORAL, SOCIAL, AND INFORMATION SCIENCES

Committee view

The Committee directs that funds for programs in the Cognitive Science and Anthropology program elements of the Behavioral and Neural Sciences Division, and in the Social and Economic Science Division be restored to at least their approximate 1980 levels. In addition, it is directed that the Information Science subactivity be increased by $2 million to a level of $8.1 million. This would require an increase of $15 million to these areas of the Biological, Behavioral and Social Sciences (BBS) directorate, from the Administration request of $42.9 million to $57.9 million.

The increase would be accomplished without adding to the overall budget request, by redistributing small amounts from several of the other research directorates and from the Biological and Neural Sciences program elements of the BBS directorate. This will still allow for a 19 percent to 20 percent increase in each of the directorates from which the amounts are taken, and will permit continuation and strengthening of programs in the behavioral, social, and economic sciences that are being recognized increasingly for their importance in our society.

The Committee intends that a strong focus be made on problems of productivity and improvement of the economy, and the Foundation is directed to keep this in mind when distributing the increased funding among these subactivities.

Discussion

Again this year, the Committee is greatly concerned by the disproportionately low funding for the behavioral, social, economic and information sciences requested in the Foundation's 1984 budget. Of the $33.4 million increase requested for the Biological, Behavioral and Social Sciences (BBS) Directorate, only $8.3 million is for the behavioral, social and information sciences. This follows a consistent pattern of low budget requests beginning with FY 1981.

The Committee finds it difficult to understand why, when the importance and need for emphasis on human factors in dealing with productivity problems has been increasingly demonstrated, the Foundation continues to under-support those parts of the BBS Directorate that could help find the answers to such problems.

The Director of NSF has indicated that the substantial increase requested for the 1984 NSF budget reflects the importance of basic research in laying the groundwork for sustained economic recovery. But, as was pointed out repeatedly in testimony before the SRT Subcommittee, those goals cannot be reached by emphasizing the importance of research in the physical and natural sciences alone. Much of our productivity problem has behavioral, rather than technological roots. Much of our capital stock consists of human skills, not machinery and equipment. A witness from the University of Michigan stated that one-third of the computer services at his university are used by the behavioral sciences. Improvement in aviation safety, the need to understand personal savings behavior and health habits, the need for knowledge of human cognitive processes in use of computers, are a few examples of the increasing need for behavioral sciences in solving problems of our

economy. Measurement activities such as longitudinal data bases, which monitor family income dynamics and national electoral behavior over a number of years, are invaluable in understanding complex processes such as economic productivity and recovery.

A real concern of the Committee and others is that a consistent decline in support in these areas has the consequence of discouraging young scientists from pursuing careers in the behavioral and social sciences. The Committee is further dismayed to learn that the Foundation, in announcing the eligibility for its new Presidential Young Investigator Research Awards, has specifically excluded young investigators in the behavioral and social sciences from the possibility of receiving an award under this program. While recognizing the importance of encouraging researchers in the mathematical, physical, and biological sciences and engineering, as listed in the draft 1983 Awards Announcement, the Committee feels strongly that the behavioral, social and economic sciences should not be excluded. It is the Committee's view, in addition, that it is unwise for NSF to enumerate anticipated numbers of awards that will be made in any one field.

The Division of Information Science and Technology continues to be the sole source of federal funding for the support of non-mission oriented, investigator-initiated, and university-based support in the rapidly developing field of information science and technology. Testimony received during the authorization hearings emphasized the importance of information science and technology in maintaining the U.S. position in economic leadership and preserving national competitiveness in world markets.

Information science is a relatively new discipline which has natural points of contact with other disciplines, such as computer science, engineering, the cognitive sciences, and those parts of the social sciences that are concerned with information processing systems. Fundamental research problems in information science could make significant contributions to our understanding of how knowledge is represented, of the nature of learning, and of the principle of selective omission of information and its limitations.

Since information science is an emerging discipline and research in this area has strong interdisciplinary ties, federal funding is extremely important to nurture and sustain the development of research in information science and technology. In spite of this need, the history of funding for the Division of Information Science and Technology does not demonstrate a funding level commensurate with the potential contribution of research in this area to science and society. Testimony indicated that the research staff of the Division had been reduced by over one-third during the past four years, while at the same time proposal flow and quality have steadily increased. It was emphasized that because of low funding levels, important research applications in information science and proposals that require considerable instrumentation or the development of sizeable prototypes are not fundable.

Therefore, it is the Committee's view that the Division of Information Science and Technology should be given high priority and strong support within the BBS Directorate. To assure that funds are available to accomplish the identified research priorities of information science and technology, the Committee directed the

Foundation in the fiscal year 1984 authorizing legislation to make not less than $8 million available to the Information Science and Technology Division.

3. PROPOSED POLICY CHANGES IN THE STIA DIRECTORATE

Committee view

The Committee is concerned over the Administration's proposal to shift monies from the Scientific, Technological and International Activities (STIA) Directorate into the Foundation's other research directorates. Whereas this might help involve these directorates more directly in the STIA programs, including the International, Women and Minorities in science, Small Business Innovation Research and other programs, the Committee believes the proposal has not been sufficiently considered with respect to all of the short and long-term policy implications. In particular, because of the lack of detailed planning and analysis the Committee fears that the special focus and possibly entire segments of these individual programs could be absorbed and lost within the other directorates. The bill therefore calls for $23.2 million within the other research directorates to be made available to STIA to continue management of these programs. The Committee expects these monies to be reallocated to STIA by the Foundation upon final appropriation of funds for fiscal year 1984.

Further, it is the Committee view that expenditures for programs related to the underrepresented groups remain identifiable as line items. The Committee members wish to be assured that no less than the amount budgeted for these programs will be spent on them during the 1984 fiscal year. Thus, it is the Committee view that central responsibility for these programs be retained within the STIA Directorate.

Discussion

The Directorate for Scientific, Technological and International Affairs (STIA) has evolved as the repository for activities and Foundation responsibilities which do not readily fit into any of the discipline oriented directorates. Many of its programs have been added through Congressional mandate and include the programs in Women and Minorities in Science, Small Business Innovation Research, Intergovernmental Science and Technology, the Experimental Program to Stimulate Competitive Research and others. Many of these programs were originally part of another budget line item known as "Cross Directorate Activities" so named as to indicate the broad nature of these programs. In the past few years, as part of the budget reductions and other policy considerations, the Cross Directorate programs were considerably reduced and then combined with the existing STIA activities. These programs were then placed under the heading of Coordinated Agency-Wide Research Activities (CARA). More recently, further reductions and consolidation moves have resulted in assigning these programs to a new division designated the Research Initiation and Improvement Subactivity. In terms of actual funding levels the overall programs of STIA have been reduced from the pre-rescission level in fiscal year 1981 of $83.2 million to the current request level of $36.8 million.

As also proposed, an additional $23.2 million for STIA related activities exist throughout the rest of the research directorates.

Apparently, the decision to shift monies from STIA into the other directorates came late in the budget process in January, 1983. Thus, little or no real analysis has taken place in order to introduce this "matrix management" initiative. Further, the details of such a proposal are lacking, the Foundation being unable to provide information at the date of preparing this report as to where exactly the various components of the $23.2 million in funds reside within the discipline-oriented research directorates.

Regarding those programs aimed at women, minorities, and the handicapped, these programs, unlike most other activities in the other directorates, will not receive a line item increase in funds in fiscal year 1984. The requested amount for the Minority Research Initiation Program is 20 percent less than was requested for fiscal year 1983. The amount requested for the Visiting Professorships for Women Program is level with that spent in fiscal year 1983. While the request for the Research Improvement in Minority Institutions Program is the same as in 1983, all efforts aimed at the handicapped appear to have been eliminated within STIA. All of these programs differ from those now carried on through the research directorates in that their primary aim is not to generate more research of one kind or another. Their primary aim may be said to be to generate more people who are qualified to carry on high quality research and to gain for these people the personal recognition that is essential if they are to carry on their work in institutions worthy of their talent.

National Science Foundation officials propose through the new management plan to integrate these people-oriented programs into the research-oriented directorates on the rationale that such programs should be the responsibility of each and every directorate. A second reason given for the integration is that it would result in higher levels of funding for such programs.

Non-NSF witnesses, while acknowledging the potential benefits of such an integration, were not convinced that such benefits would be forthcoming unless the programs remain identifiable as distinct entities, and unless someone remains responsible for the carrying out of the programs. A fear was voiced that the programs and the efforts of NSF toward underrepresented groups could disappear entirely under the proposed management plan. To give responsibility to all generally is to give it to no one specifically. And to ask the research directorates to set aside a portion of their limited funds for one type of effort—and one that is not primarily a research effort—is to impose on the officials of the directorates a request they might not entertain readily and might not fulfill vigorously.

A similar problem exists regarding the international programs of STIA. Unlike the other activities discussed, these programs have always enjoyed a relatively independent status as one of the core activities of STIA. De-emphasis in international science cooperation in recent years has led to a number of reductions and limits to the international programs. As part of the proposed policy implied by the management plan more than half of the international program monies would be managed by the other directorates. This would occur despite their lack of expertise in international affairs, policy

directives and the broader, diplomatic goals of these special programs. Because these international programs will be placed into direct competition with domestic programs many doubt that the international components will survive given other priorities of the discipline oriented directorates.

Finally, in reviewing the Administration's proposal to eliminate the Experimental Program to Stimulate Competitive Research in fiscal year 1985 the Committee notes their strong objections to this proposed action. The competitive grants program has enjoyed imminent success in the short time it has existed. The Committee believes that this program, designed to improve science education and research capabilities in areas and institutions that desire to become more competitive, should be established as a permanent program within the Foundation's activities. The Committee feels strongly that the relatively small investment in resources targeted for this program is more than balanced by building a broader base for scientific achievement in this country by promoting more equitable, geographical distribution of research support.

4. RESEARCH INSTRUMENTATION

Committee view

The Committee strongly endorses the 60 percent increase in support to be given to replacement and renewal of research instrumentation. The proposed level of $180 million for fiscal year 1984 represents a $68 million increase over fiscal year 1983 expenditures for instrumentation and increases expenditures in this category to 14 percent of the NSF budget total. The Committee wishes to emphasize, however, that it will require a sustained investment over several years to revitalize university laboratories so that they continue to lead the world in scientific research. The Committee realizes that NSF does not have the resources to single-handedly support all the new instrumentation needed by research universities, even over a period of several years. The Committee does expect that the NSF will be an aggressive lead agency in encouraging other Federal agencies, state and local governments, and the private sector to support the renewal of university research facilities.

The Committee intends that NSF be creative in the use of its instrumentation funds to stretch them as far as possible. The Committee recognizes that the Foundation has a variety of programs underway which encourage sharing of equipment and facilities. When appropriate, the Foundation should require matching funds for instrumentation; or, by providing adequate funding support for a specific research area, support the utilization of equipment purchased with other than NSF funds.

The Committee encourages the Foundation to require reasonable cost sharing on major research instrumentation awards. The Committee intends to provide the Foundation with great flexibility in this matter. As the bulk of the instrumentation funds are to be awarded by individual programs within the research directorates, the Committee recognizes that the different needs of the various programs will affect the decision on whether to require cost sharing and at what level. The Committee's concern is fairness. The cost sharing requirements should not be so high as to freeze out a

large number of institutions whose proposals would otherwise be competitive. However, neither should the proposal guidelines allow institutions to avoid serious attempts in securing such cost sharing. The Foundation will have to move carefully to ensure that cost-sharing programs are fair and equitable to all prospective grantees.

The Committee is pleased that the Foundation is developing "indicators" on the status of research instrumentation as requested in last year's report 97-485. Clearly there is a need to be able to estimate the magnitude of the current instrumentation and facilities problem, to continously monitor the status of university research instrumentation and facilities, and to assess the success of programs for instrumentation and facilities renewal. The Committee expects this project to be a continuing effort over the years so that any changes in the status of university instrumentation will be seen. The Committee also expects reports to be issued quickly and frequently so that appropriate budget actions can be taken in a timely manner.

The Committee intends the additional $50 million added for instrumentation for high opportunity R&D to be specifically targeted to support new research initiatives, new laboratory development and to acquire technology for the delivery of instruction in public and private, post-secondary institutions. It is intended that these grants be institutional in nature rather than being targeted to individual principal investigators. The Committee realizes that a new research initiative at one university may be quite routine for another; however, the Committee's intention is to get more universities involved in advanced research areas with high opportunity potential. These typically have a high capitalization threshhold for instrumentation. Many of these opportunities exist in such traditional disciplines as chemistry, physics, mathematics and engineering. Examples include robotics, supercomputers, biotechnology, advanced materials, image enhancement, information networks, cryogenics and very large scale integrated circuit design, among others. It is also the Committee's intention that some of these funds may be used to support the delivery of computer based instructional materials. The Committee further intends that some of these new monies be used for accessibility to satellite information by universities. Such programs should be coordinated between NSF, the Department of Energy and other Federal agencies.

Discussion

Previous testimony before this Committee described the cost of remedying the shortfall in university instrumentation to be, in an admittedly very rough estimate, $1 billion to $4 billion. In the last year, more detailed studies have started to emerge. A study conducted by the National Society of Professional Engineers shows that $1.2 billion will be needed to restore engineering instructional laboratories to their 1971 condition and an additional $1 billion will be needed to cope with the increased student enrollment since that time. An informal survey of university analytical chemistry labs published in Chemical and Engineering News showed that the instruments in laboratories at six top-echelon universities are currently capitalized at an average of $3.6 million each and spend about 10% of that amount as an annual maintenance cost. Their

anticipated cost of needed additional equipment to fulfill future laboratory requirements averaged $800 thousand. Universities classified as second-echelon were significantly less well-equipped, with an average capital value of $2.7 million for their instruments. These institutions estimate that they will need to add an additional $1.4 million of instrumention on the average to meet future needs.

A number of additional studies are being conducted by other organizations. The results of these studies, when coupled with the "indicators" project of the Foundation, should result in the first comprehensive and accurate assessment of the state of university research instrumention. The Foundation should take the lead in integrating the results of these various studies into a coherent whole.

The Interagency Working Group on University Research Instrumentation, organized and chaired by the Foundation, appears to be performing a very important role in coordinating agency activities with respect to instrumentation and in undertaking specific projects in the field. A collabrative project to increase awareness among research universities of opportunities for better planning and management of research instrumentation resources has been initiated by the Working Group in conjunction with three university organizations. The Committee heard testimony on the use of debt financing by universities to acquire research equipment and on the problems current federal regulations pose in the wider use of debt financing and in the donation of equipment to universities by the private sector. The collaborative project will assess the role of debt financing in sound university financial practice, will assess tax incentives and other routes to increased private sector support, and will propagate these results, along with the results of other activities, by seminars, meetings, and symposia. This appears to be a particularly valuable activity of the Working Group. In the Committee's view, a strong and active Interagency Working Group should continue to head Federal activities in addressing the university instrumentation problem.

This Committee has supported many research initiatives over the past two decades to develop the methodology and the technology of computer-based education. Many of these initiatives led to commercialized products for the delivery of instruction. Our universities now face serious shortages of qualified faculty members in some areas of science and engineering. It is now altogether appropriate to assist colleges and universities in capitalizing the technology to be used for primary delivery of instruction (as opposed to development, enrichment or demonstration) as one approach to mitigating the problems associated with the faculty shortage.

It is noted that the software costs, fees and royalties are often significant or preponderant portions of the total costs associated with Very Large Scale Integrated Circuits, Computer Aided Design/Manufacture or Computer Based Education instruments, and where such costs are an integral part of the instrumentation these costs should be considered as eligible for these funds. More broadly the Committee feels that the Foundation should consider such costs as relevant to supporting good research in general and that further consideration be given to including these costs within individual grant proposals other than those contemplated under the new instrumentation fund.

The Committee notes that its overriding concern is the support of vigorous and high quality programs and not just the ownership of hardware; therefore, whenever the proposer finds it prudent to utilize instruments already available from public, private or consortia sources rather than to buy such instruments, these funds may be used to pay access fees or user charges. Examples would include satellite channels and supercomputer time among others.

Regarding accessibility to supercomputers by universities, priority for accomplishing such an access should be given to those supercomputers now owned by universities or government facilities such as those at the National Center for Atmospheric Research in Boulder, Colorado, the Magnetic Fusion Lab at the Lawrence Livermore Laboratory in California, and the facility at Colorado State University. The funding for this should be limited primarily to new initiatives and new development. Such funds can be used to cover hardware/software costs, access fees, and other related fees. The Committee recognizes that future networking needs may necessitate the purchase of additional supercomputing systems. The Foundation should keep in mind that this networking system may be altered as a result of such changes.

Finally, the Committee is concerned that a workable system still does not exist to assure that funds allocated in individual grants for instrumentation are expended in a manner consistent with the intent of the award. The bulk of the instrumentation funds proposed to be distributed in the coming budget year will be through the individual grant. It seems reasonable then that the Foundation be able to demonstrate to the Congress that these expenditures for instruments actually occurred. At the minimum, careful examination of renewal proposals for evidence of equipment expenditures should be initiated. Ideally, the instrumentation "indicators" program will rapidly reflect equipment acquisition by grantees.

5. AAEO DIRECTORATE

Committee view

The Committee is very pleased with programs of the Astronomical, Atmospheric, Earth and Ocean Sciences Directorate. Results of research projects supported by this Directorate have revolutionized our view of this planet and the universe. In the Committee's opinion, the strong support of the Foundation for these areas of science has been a major, if not the major, factor in the continued U.S. preeminence in these fields. The research has resulted in not only dramatic increases in our understanding of the fundamental processes at work in the universe and on our planet, but also have provided the basis for advances of a practical nature which have the potential for major contributions to economic development and public safety.

The Committee realizes that, as we attempt to reach deeper into and further out of the earth, the research tools become even more expensive. Large telescopes and oceanographic research vessels cost millions of dollars, as do the super computers required for the successful modeling of the global climate. Funds available for new major facilities are limited, and the Foundation will need to carefully prioritize the needs not only within the various scientific pro-

grams within the AAEO Directorate but between Divisions and between Directorates in the NSF. The Committee finds studies such as the Academy of Sciences report on Astronomy extremely valuable in helping it understand the important needs in a scientific discipline. The Committee encourages the Foundation to develop similar studies in other disciplinary areas on a regular basis. The Committee recognizes, however, that these sorts of studies are of less value in choosing between a new telescope and a new research submersible, for example. Here the National Science Board should play a major role in decisionmaking.

Discussion

The Foundation provides about two-thirds of the total support for ground-based astronomy in the United States. Over the years the Foundation has built an impressive series of observing facilities to serve U.S. astronomers in the radio, infrared, and visible wave lengths. In addition, a grants program also supports both university facilities and individual astronomers.

The Committee views it as essential that the U.S. continue to have a strong program in ground-based astronomy. Certainly space astronomy has a unique and important role to play in the country's overall astronomy research program. The space telescope, for example, will provide observations in the visible, ultraviolet, and near-infrared wavelength regions free of clouds, atmospheric turbulence, and airglow. Observations at the X-ray and Gamma-ray wavelengths can only be made from space. However, space astronomy is expensive and the number of instruments available for observations is limited. The great bulk of astronomical observations will continue to be made from the Earth for many years to come. The Committee thus strongly agrees with the Foundation's plans to increase support of its astronomy programs by 26 percent, from $63,000,000 to $79,300,000. The Committee also fully approves of this Foundation's plans to use much of the increased appropriation to upgrade instrumentation and computational facilities at both university observatories and at the National Astronomy Centers.

Each increase in the capacity, sensitivity and resolving capability of astronomical instruments have resulted in new discoveries and revised theories about our universe. The Committee realizes that astronomical instruments must continue to evolve if scientific progress is to continue. Thus the Committee supports the initiation by the Foundation of design studies for the construction of the two new ground based facilities given the highest priority by the NAS study: the Very Long Base Line Array Radio Telescope and the New Technology Optical Telescope. The Committee wishes the Foundation to keep the Committee apprised of the progress of these studies and the potential costs of these instruments.

The Committee is particularly concerned that the situation be resolved with respect to the Infrared Telescope Facility (IRTF) in Hawaii, currently supported by NASA. NASA wishes to cease support and has expressed a hope that NSF will pick up support for the IRTF. The Committee does not wish to see the closure of a facility only four years after completion at a cost of over $10 million. A research facility such as the Infrared Telescope Facility cannot operate efficiently when funding crises occur every fiscal year.

Therefore, the Committee has directed NASA to continue support for the Infrared Telescope Facility until an interagency agreement between NASA and NSF is completed that provides for NSF support of the facility or until an independent, outside, scientific peer review finds that the facility should be closed. The Committee holds no view as to which agency should support the facility, but does expect the two agencies to resolve the issue promptly.

Ocean drilling

The Committee recognizes that the Deep Sea Drilling Project has made major contributions to both the earth science and oceanographic research areas. The program has provided much confirmatory evidence for plate tectonic theory and has developed much of the data that are used to understand the climates of past ages. Based on the accomplishments to date, a continuation of a drilling program appears to be appropriate if it can be done in an affordable manner. For five years the Foundation has sought to convert the *Explorer* for use in the Advanced Ocean Drilling Program (AODP). The Committee is concerned that research in the field has lagged behind during the five year period.

Therefore, the Committee encourages the Foundation to proceed expeditiously with the recommendation of the members of the Ad Hoc Advisory Group on Crustal Studies to lease the most effective commercially available modern oil exploration drill ship. Selection of one such vessel as the drilling platform for AODP, in the Committee's view, appears to be the most cost-effective and realistic approach as opposed to either the *Explorer* or *Challenger* options.

In fiscal year 1983, one third, $8 million, of the support for the Deep Sea Drilling Program was provided by othe nations. This support is scheduled to decrease to $1.2 million in fiscal year 1984. It appears that the Foundation was unable to complete a realistic plan for continuation of ocean drilling program in time for our foreign partners to include their contributions in their individual budget processes. Therefore, the Foundation is forced to devote more than $6 million of its resources to cover this shortfall.

The Committee expects the Foundation to move aggressively and rapidly to complete its plans for a continued ocean drilling program to keep the Committee informed as to the progress of its studies on the commercial vessel leasing option, and to work diligently to obtain maximum foreign participation in and contributions to the program.

Oceanography

Oceanographic research has played a key role in man's quest to understand his Earth and the processes that led to life upon it. Sea-floor data gathered by oceanographers in the first decade after WWII provided the foundation for the plate tectonic theory which is now widely accepted as the best explanation for the movements of the earth's crust. The recent discovery of a sulfur-based food chain at a mile-deep hot spring has shown that a chemical as well as a photosynthetic basis can exist for life.

These and most other major discoveries in the oceans have been made by U.S. scientists supported by the Foundation and/or the Office of Naval Research. The return on investment in terms of the

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generation of basic knowledge about our planet has been enormous. However, with the decline of ONR support of academic basic research, the burden of maintaining a dynamic ocean research program has fallen mainly to the Foundation.

The Committee believes that NSF has done a very good job of assuring a strong U.S. ocean program in a time of contracting fiscal resources. The fiscal year 1984 basic research budgets may represent a reversal of declining research capability after inflation, but it is unlikely that growth of support will return to the rates of the sixties. The problem will be compounded by the need for ever more sophisticated and expensive equipment to enable American scientists to stay on the cutting edge of the field. Oceanography is a complex, multidisciplinary activity, as such it is very difficult to a consensus of the research community on project priorities. However, it appears that this may be changing. Dr. Spencer of Wood Hole testified, "There is growing recognition among academic ocean scientists that in the most likely economic conditions of the future, we must learn to order new priority thrusts". The Committee urges the Foundation to insist on such an ordering of research opportunities by the research community and to provide resources if necessary to enable it to occur. The community must realize that if it fails to do so, other groups will.

Earth and Atmospheric Sciences

The Committee did not take testimony on the programs in either the Earth or Atmospheric Science divisions of the Directorate due to time constraints. This does not imply that the Committee considers these programs to be any less important as research areas for the AAEO Directorate or the Foundation. The Committee recognizes that the many research accomplishments in these programs not only have made major contributions to the knowledge base in the earth and atmospheric sciences, but have the potential to underwrite major economic payoffs extraction, climate prediction, and the control of atmospheric pollutants. The Committee fully supports the foundation's proposed budgets and initiatives in these Divisions.

6. UNITED STATES-INDIA JOINT RESEARCH PROGRAM

Committee view

The Committee considers the new U.S.-India Joint Research program an important element of our overall cooperative science efforts. The Committee believes, however, the new initiative should not be undertaken at the expense of ongoing and highly regarded India-U.S. cooperative programs that have enjoyed considerable success in recent years. The Committee believes the $2.0 million provided as part of the Foundation's research activities for the new India initiative should not require monies to be spent from the limited Special Foreign Currency (S.F.C.) account as originally requested and which is designed to provide the minimum support for the other ongoing program grants. Recognizing, however, the need for additional monies with the Foundation's designation as lead agency for the new initiative, the Committee has acted to authorize an additional $400,000 for the Special Foreign Currency account for this

purpose. It is intended that the Foundation's share for such coordination not exceed this amount and that the remaining funds in the S.F.C. account be used only for the ongoing grant programs. It is anticipated that a supplemental appropriation request will be neccesary to appropriate any needed new additional amounts.

Discussion

In January, 1983 the U.S. and India agreed to specific scientific topics of research for a new, expanded program of collaborative activity by U.S. and Indian scientists and engineers. The new program followed from an intital agreement made between President Ronald Reagan and Indian Prime Minister Indira Gandhi in 1982. The specific areas of proposed research focused on health, agricultural and biomass production, monsoon forecasting, and decentralized electrical power sources. The Foundation was named at that time as the lead agency for overall coordination of the new program, which also involves the Agency for International Development and the U.S. Department of Agriculture.

Although the fiscal year 1984 Administration request did include $2.0 million within its Research and Related Activities for the new U.S.-India Joint Research Program, no additional moneys were included for coordination costs. Apparently, the lead role designation (and hence the associated attendant costs) came too late in the budget process for inclusion in the President's request to Congress. Current estimates indicate that such costs may be between $300,000 and $1,500,000, the latter amount including all Federal agencies' costs for coordination. Because of directives from OMB, these additional moneys would have to be taken from the Special Foreign Currency account, rather than the Research and Related Activities account. Hence, without increasing the S.F.C. account or without using other resources, moneys designed to support ongoing research grants would suffer major reductions. Many of such ongoing programs have been supported with a record of distinction and excellence for more than a decade. To reduce such support seems inappropriate and unjustified, in the view of the Committee. Without the addition of moneys to S.F.C., highly successful projects, involving over 36 American universities and colleges and hundreds of researchers, would be unintentionally reduced and some possibly eliminated.

7. RESEARCH TO AID THE HANDICAPPED

Committee view

The Committee continues to support the Science and Technology to Aid the Handicapped Program. The original program was authorized in fiscal year 1979 at $2 million. In fiscal year 1980, the Committee recommended expanding the program and requested funding of $2.8 million. In fiscal year 1981, the funding level of the program was reduced to $1.6 million, and in fiscal year 1982 it was reduced even further to $646,823. Although the Administration's fiscal year 1983 budget called for zero funding for the program, the House and Senate Authorizing and Appropriations Committees recommended restoring the program at a funding level of $2 million.

Accordingly, the Foundation reinstated this important program at this level in fiscal year 1983.

The Committee continues to believe that the Foundation is in a unique position to further research which leads to the development of technical solutions to debilitating handicaps. Accordingly, the Committee commends the Foundation for continuing this research and for including the Science and Technology to Aid the Handicapped Program as a line item in the fiscal year 1984 budget with a modest increase of $300,000 for a total of $2,300,000. Furthermore, the Committee encourages the strengthening of this program and directs the Foundation to continue to include it as a line item in future budgets.

8. ANTARCTIC/ARCTIC RESEARCH POLICY

Committee view

The National Science Foundation has full responsibility for the maintenance of an active and influential U.S. presence in Antarctica. The Foundation has carried out this mandate with a strong program of scientific research conducted under extremely difficult conditions. The Committee fully intends to provide the Foundation with the resources to continue a strong program in this area of great geopolitical importance to the country. Thus, the Committee supports in its authorization as absolutely necessary the Foundation's request for increased funds for both research and operations.

Unlike the situation in the Antarctic, twelve Federal agencies are involved in Arctic research and NSF provides only 15 percent of the Federal research support in this region. There is no evidence that the country has any overall policy to guide its Arctic research programs. Nor is there any agency or other body with the responsibility for tracking the Arctic research efforts of these twelve federal agencies and for analyzing the overall comprehensiveness of the federal research effort. Questions of needs, priorities, duplication, coordination, and cooperation are not being addressed. The Committee views the National Science Foundation as the appropriate Federal agency to analyze the current U.S. research effort in the Arctic as to scope and direction. The Committee believes the Foundation has both the detachment and the staff skills to do such a comprehensive analysis. This will be a critical step in helping the Committee determine if policy guidance through legislation for the Federal Arctic effort is necessary.

9. WOMEN AND MINORITIES

Committee view

The Committee continues to support the Science and Technology Equal Opportunities Act (Public Law 96-516, December 12, 198) in its purpose of increasing participation by women and minorities in science and technology. However, NSF's programs for women and minorities, located in the Research Initiation and Improvement subactivity of the Scientific, Technology, and International Affairs directorate (STIA), have not kept pace with the requirements and expectations of this Act.

For example, minority programs have been requested only at current levels or below. The National Research Opportunity Grants (NROG) program, intended to assist women scientists to begin independent research careers or re-enter the labor force, was established in 1981 but never became functional Not requested in NSF's fiscal year 1983 budget, the Science and Technology Committee directed that $2 million be added to implement the NROG program. This has not been done, and the line item does not appear in the fiscal year 1984 NSF budget request.

The Committee feels strongly that programs to increase participation of women and minorities in the scientific workplace, especially programs which have had successful beginnings, should be continued and enhanced rather than given decreased support.

It is also the Committee view that NSF officials should review its determinants of eligibility for funds under programs aimed at improving participation of underrepresented groups in the sciences. Criteria which unduly exclude certain minority groups and institutions located in certain regions of the country should be revised so as to allow qualified groups, institutions, and states fair access to the funds.

Discussion

Several areas of concern with respect to programs to increase the participation of groups now underrepresented in the sciences were brought to the attention of members in the course of testimony on the fiscal year 1984 NSF authorization. Two of these concerns are: (1) The present list of minority groups eligible to apply for grants under some of these programs does not include by name certain groups, such as United States born Asian Americans, who are underrepresented in the sciences; (2) Some program regulations have the undesirable effect of excluding from participation all colleges and universities in certain states such as California which have very large populations of ethnic and racial groups underrepresented in science.

Asian Americans are not specifically designated as underrepresented in science by the National Science Foundation because when foreign born Asian scientists working in the United States are counted, Asians are not underrepresented. This manner of counting, however, ignores National Research Council data suggesting that native born Asian Americans are underrepresented in the sciences. In fact, as many as 90 percent of scientists from Asian backgrounds working in the United States were not born in the United States. The effect of not including native born Asian Americans among the underrepresented is to exclude from eligibility to apply for funding some universities which must count members of this group in order to achieve the eligibility requirement that their institution serve a student body composed of at least 50 percent minority group students. some institutions excluded both because native born Asian Americans are not counted and because of the 50 percent requirement, have a larger minority enrollment than do many of the institutions that meet the requirement. For example, one California institution which has the highest enrollment of minorities of any institution in the continental United States when absolute numbers are considered is ineligible to apply for funding

under the NSF Research Improvement in Minority Institutions Program. The present regulations would, therefore, not appear to serve the best interests of most minority students hoping to pursue a career in science.

A secondary effect of the 50 percent requirement and the current ineligibility of certain minority groups is that some states with large numbers of citizens from minority groups do not have a single institution meeting the minimum requirements for funding eligibility. This means that no minority student in the state can receive the benefits of the relevant NSF programs. California can again be used as an example. With nearly 8 million citizens from a minority background, California has more blacks and Asian Indians than any state except New York. It has more Hispanics, Native Americans, Chinese, Filipinos, Japanese, Koreans and Vietnamese than any other state in the union. Again, only New York has more college age black citizens than does California. And California has sixty-two percent more college age Hispanics than any other state. As an indication of the future, no state exceeds California in the number of minority children now enrolled in public elementary and secondary schools. But there is not even one institution of higher learning in the state of California that qualifies under present NSF requirements as a minority institution.

10. EARTHQUAKE RESEARCH

Committee view

The National Science Foundation conducts earthquake research as part of the multiagency National Earthquake Hazards Reduction Program (NEHRP). The Foundation sponsors basic and applied research on earthquake processes and phenomena in its geophysics program and on earthquake engineering and socioeconomic implications of earthquakes it its civil and environmental engineering program. NSF's societal response program supports research on the responses of individuals, organizations, and communities to earthquakes and related hazards.

In the Committee's view, the NSF programs are a critical part of the NEHRP program. The Committee fully intends this important research program to continue with $27.3 million as the amount authorized for fiscal year 1984. However, in the last few years a double authorization of this program has been made. Funds for the program have been included both in the NSF authorizing legislation and in legislation authorizing the Earthquake Hazards Reduction Program. The Committee considers the double authorization to be undesirable and intends to take appropriate action to provide one authorization. This action will not, in any manner, indicate lessened Committee support for NSF's portion of the earthquake research program. The Committee fully expects this important research activity to continue.

11. SCIENTIFIC COMPUTING AND NETWORKING

Committee view

The Committee directs the NSF to submit to the Congress by January 30, 1984 a report defining: national needs for access to sci-

entific computing and computer communications networks linking various subsets of the academic, industry, and government scientific community; research needs in software, algorithms, and numerical analysis to effectively utilize supercomputers and new generation machines; use and limitations of computer networks directly or indirectly supported by Federal agencies, such as CSNET, ARPANET, and EDUNET, and their ability to achieve projected needs; operation and functional services necessary to administer computer networks and stimulate resource sharing; recommendations regarding effective means of operating and financing computer networks, including access to supercomputers; and recommendations concerning effective institutional arrangements for achieving projected needs, including the role of Federal agencies, national laboratories, not-for-profit organizations, and the private sector. NSF is directed to draw on the expertise of a broad range of scientists to develop the scope and recommendations of this report.

Discussion

The Committee believes that large scale computing is an essential component of science, engineering, and technology advancement and transfer. Therefore, it is imperative that the U.S. undertake the necessary investments to maintain our current leadership advantage in large scale computing and networking. Significant new research and development efforts are needed to provide adequate access to supercomputers for all disciplines, to stimulate the generation of very high performance computers, and to train scientists in their use.

The Committee congratulates the Foundation for sponsoring, with DOD in cooperation with DOE and NASA, the workshops which led to the Report of the Panel on Large Scale Computing in Science and Engineering (December 26, 1982). The Committee supports the recommendation of the Panel that a "National Program to stimulate exploratory developments and expand use of advanced computer technology" be established. It is not the intent of the Committee that the report requested above replace the mission of an interagency policy committee, as recommended by the Panel, to coordinate a "National Program" in this area. However, the Committee believes the report requested will assist NSF and the Congress in focusing on national needs for scientific computing and networking which can utilize existing research and computing facilities to the greatest advantage in the near term. Likewise the report could make an important contribution to the work of an interagency policy committee to coordinate a "National Program".

The Committee assumes that NSF will accept a leadership role in the work of the interagency policy committee to plan, implement, and operate a long-term National Program on large scale computing. In addition, NSF is directed to submit to the Committee periodic progress reports outlining the activities of the Foundation designed to support research and development in hardware and software related to large scale computing, to enhance access for the scientific and engineering research community to supercomputer facilities through high bandwidth networks and other means, and to motivate training in scientific and engineering computing.

III. Explanation of Committee Amendments

The amendment in the nature of a substitute adopted by the Committee is presented at the beginning of this report.

EXPLANATION

The Committee adopted an amendment in the nature of a substitute which:

(1) Authorizes a total of $1,342,700,000 for operations of the National Science Foundation for fiscal year 1984. This amount, which is $50,400,000 larger than the Administration's request, is an increase of $245.5 million or 22.4 percent over the amount provided to the Foundation in fiscal year 1983. The funds are to be distributed as follows:

(a) Mathematical and Physical Sciences are increased by $58.9 million (19.7 percent) over the fiscal year 1983 amount to a total of $358.6 million.

(b) Engineering is increased by $20.2 million (20 percent) over the fiscal year 1983 amount to $121 million.

(c) Biological, Behavioral, and Social Sciences are increased by $46.2 million (24.2 percent) over the fiscal year 1983 amount to $236.4 million.

(d) Astronomical, Atmospheric, Earth and Ocean Sciences are increased by $53.6 million (19.4 percent) over the fiscal year 1983 amount to $329.8 million

(e) The U.S. Antarctic Program is increased by $18.9 million (22.7 percent) over the fiscal year 1983 amount to $102.1 million.

(f) Scientific, Technological, and International Affairs is decreased by $7.4 million (16.7 percent) below the fiscal year 1983 amount of $36.8 million.

(g) Science and Engineering Education is increased by $9.0 million (30 percent) over the fiscal year 1983 amount to $39.0 million.

(h) Program Development and Management is increased by $700,000 (one percent) over the fiscal year 1983 amount to $66.0 million.

(i) Special Foreign Currency is decreased by $100,000 below the fiscal year 1983 amount to $3.0 million.

(j) A new Research Instrumentation Initiative is authorized at $50.0 million.

(2) Requires that fifteen percent of the sum of the amounts authorized for the MPS, Engineering, and AAEO Directorates be used for research instrumentation. The Foundation intends to allocate more than this required amount for research instrumentation. The legislative requirement is intended to assure accountability.

(3) Requires that, of the funds provided for Biological, Behavioral and Social Sciences, not less than $8 million will be spent on Information Science and Technology. The provision assures that a $2 million increase over the Administration's request provided to NSF for this subactivity will be used for this purpose.

(4) Requires that an additional $23.2 million from the amount authorized for Research and Related Activities be reallocated to the

Directorate of Scientific, Technological, and International Affairs. Funds may not be taken from the Antarctic Program, however.

(5) Requires that, if the funds appropriated are less than the amount authorized, the funds are to be apportioned among activities in the same proportion as they are apportioned in the authorization bill.

(6) Restricts the authorization period to fiscal year 1984.

(7) Section 9 of the National Science Foundation Act of 1950, as amended, is amended to read as follows:

(a) Each special commission established under section 4(h) shall be appointed by the Board and shall consist of such members as the Board considers appropriate.

(b) Special commissions may be established to study and make recommendations to the Foundation on issues relating to research and education in science and engineering.

Section 4(h) of the National Science Foundation Act authorizes the National Science Board to establish "special commissions" from time to time as it may deem necessary for the purposes of the NSF Act. Such a commission can be a useful means of focusing the attention of distinguished scientists and other citizens on specific problems relating to science. However, limitations on the composition and duties of special commissions imposed in section 9 of the Act have unfortunately limited their value and therefore their use.

Section 9(b) of the NSF Act restricts any special commission to making a "comprehensive survey of research" and formulating and recommending to NSF an "over-all research program" for a particular scientific field of study. The Foundation believes that special commissions would be more helpful and used more often if the commissions' writs could be drawn more broadly. The proposed amendment would authorize the Board to establish special commissions to study and make recommendations on any issues relating to the principal areas of responsibility of the National Science Foundation.

Section 9(a) restricts the membership of any special commission to six scientists and five non-scientists. Though this may be a good number and a good distribution for many cases, it is extraordinarily rigid. In many cases it would prevent selection of the best mix of scientists who are experts or specialists in the issues to be addressed, scientists who are not specialists in these issues, and non-scientists. The proposed amendment would allow the Board discretion to take account of the subject and the circumstances in fixing the size of a special commission and determining its composition.

No significant increase in cost or personnel will result if the proposal is enacted. Moreover, most, if not all, special commissions established would be considered to be subject to the requirements of the Federal Advisory Committee Act.

(8) Section 6 of Public Law 95–99 directed the Foundation to establish a resources Center for Science and Engineering to be located at an educational institution. Four such centers have been funded.

This section of the Foundation's annual authorization act was permanently codified in the U.S. Code as 42 U.S.C. § 1884, apparently as a matter of codification committee routine. The Foundation sees no reason for this codification. No other specific programs

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of the Foundation initiated at the direction of the Congress have been permanently codified. Moreover, authority for establishing such centers is now covered under the Science and Technology Equal Opportunities Act (42 U.S.C. §§ 1885–1885d), making this section redundant. Deletion of the section will simplify the law.

No increase in cost or personnel will result if the proposal is enacted.

(9) Section 10 codified as 42 U.S.C. § 1873a, was added in 1977 to require NSF employees to disclose any financial interests or academic affiliations that might bear on their handling of proposals or other applications. It also required that the NSF adopt implementing regulations. It is unique, as no other agency of the Federal Government is subject to specific statutory requirements in this area. The broader disclosure requirements of the Ethics in Government Act are binding on all agencies, including the NSF. (In fact, under subsection (d), § 1873a(d), most of this section was superseded by the Ethics in Government Act.) Moreover, all agencies are required by Executive Order 11222 to maintain conflict-of-interest regulations that deal with any problems unique to their programs and methods of operation.

The Foundation's conflict-of-interest regulation was extensively revised last July (45 CFR Parts 680 through 684; published in the Federal Register, Vol. 47, No. 143, July 26, 1982, on pages 32130 through 32153). The new regulation requires both disclosure of all potentially biasing affiliations or relationships and special oversight in cases involving them, with further special handling if necessary (45 CFR Part 681). The statutory provision is thus no longer necessary, and its deletion would simplify the law and allow more scope for future evolution of NSF policy in this area.

No increase in cost of personnel will result if the proposal is enacted.

(10) Subsection 12(b) of the NSF Act, codified as 42 U.S.C. § 1871(b), bans an NSF employee from owning a United States patent on any invention made in connection with and directly relating to the subject matter of his or her assigned duties.

The Foundation is believed to be the only Federal agency to have a statutory provision governing the allocation of rights to inventions made by its employees. All other agencies are governed by Executive Order 10096, as amended, which permits Federal employee-inventors to retain principal patent rights to their invention under certain circumstances. (See Section 1(c) of E.O. 10096 and the implementing regulations of the Patent and Trademark Office published at 37 CFR Part 100.) No reason is known for this special restriction on the Foundation's employees. The provision probably resulted from a general congressional concern over the treatment of Federal employees' inventions, which President Harry Truman assuaged by issuing E.O. 10096 in January 1950, just four months before the NSF Act became law.

As far as can be determined, the provision has had no actual effect on the Foundation's employees. The NSF, after all, performs no "in-house" research that could produce inventions. Only one invention has ever been reported by a Foundation employee.

Deletion of this provision would simplify the law and remove an inequitable distinction between the Foundation's employees and those of other Federal agencies.

No increase in cost or personnel will result if the proposal is enacted.

IV. Changes in Existing Law Made by the Bill, as Reported

In compliance with clause 3 of rule XIII of the Rules of the House of Representatives, changes in existing law made by the bill, as reported, are shown as follows (existing law proposed to be omitted is enclosed in black brackets, new matter is printed in italics, existing law in which no change is proposed is shown in roman):

National Science Foundation Act of 1950

SPECIAL COMMISSIONS (42 U.S.C. § 1868)

SEC. 9. [(a) Each special commission established pursuant to section 4(h) shall consist of eleven members appointed by the Board, six of whom shall be eminent scientists and five of whom shall be persons other than scientists. Each special commission shall chose its own chairman and vice chairman.

[(b) It shall be the duty of each such special commission to make a comprehensive survey of research, both public and private, being carried on in its field, and to formulate and recommend to the Foundation at the earliest practicable date an overall research program in its field.]

(a) Each special commission established under section 4(h) shall be appointed by the Board and shall consist of such members as the Board considers appropriate.

(b) Special commissions may be established to study and make recommendations to the Foundation on issues relating to research and education in science and engineering.

[RESEARCH CENTER FOR SCIENCE AND ENGINEERING (42 U.S.C. § 1884)

[(a) The National Science Foundation shall establish a Resource Center for Science and Engineering to be located at an educational institution which—

[(1) enrolls substantial numbers of minority students, students from low income families, or both;

[(2) is geographically located near one or more population centers of low-income families or minority groups;

[(3) demonstrates a commitment to encouraging and assisting minority students or students from low-income families, or both; and

[(4) has an existing or developing capacity to offer doctoral programs in science and engineering.

[(b) The Center established under this section shall—

[(1) support basic research and the acquisition of necessary research facilities and equipment;

[(2) serve as a regional resource in science and engineering for the community which the Center serves; and

[(3) develop joint educational programs with nearby precollege and undergraduate institutions which enroll a substantial

number of minority students or students from low-income families. (Section 6 of Public Law 95–99).]

[FINANCIAL INTEREST—ACADEMIC AFFILIATION DISCLOSURE (42 U.S.C. § 1873A)

[(a)(1) Each officer or employee of the National Science Foundation who performs a decisionmaking function in the handling of any application or proposal for a grant from or contract with the Foundation shall provide a written statement for the record identifying (in accordance with the standards promulgated under subsection (b) any financial interest or other relevant interest he or she has in the person submitting the application or proposal and any academic affiliation he or she has with that person. If the application or proposal results in an award, the statement shall be made available to the public.

[(2) The Director shall remove or take other appropriate disciplinary action against any employee who knowingly violates the requirements of this subsection.

[(b)(1) Within 60 days after the date of the enactment of this Act, the Director of the National Science Foundation shall publish—

[(A) proposed standards to implement the requirements of subsection (a), designed to minimize conflicts of interest and to assure that the appropriate files of the Foundation relating to any grant or contract referred to in such subsection contain a statement of any financial or other relevant interest which any of the officers and employees involved may have in the person or institution applying for or proposing the grant or contract as well as any academic affiliation which any of such officers and employees may have with such person or institution; and

[(B) proposed standards appropriately requiring identification of any conflicts of interest by peer reviewers.

[(2) Within 120 days after the date of the enactment of this Act, the Director shall promulgate the standards published under paragraph (1), with such modifications as the Director may deem appropriate; and such standards shall take effect upon their promulgation.

[(c) The Director shall report annually to the Congress on the administration and enforcement of this section.

[(d) If the President issues an Executive order that requires financial disclosure by officers and employees of Federal agencies generally, only so much of this section as relates to peer reviewers and to academic affiliates of officers and employees shall remain effective. (Section 10 of Public Law 95–99)]

PATENT RIGHTS (42 U.S.C. § 1871)

SEC. 12. [(a)] Each contract or other arrangement executed pursuant to this Act which relates to scientific research shall contain provisions governing the disposition of inventories produced thereunder in a manner calculated to protect the public interest and the equities of the individual or organization with which the contract or other arrangement is executed: *Provided, however,* That nothing in this Act shall be construed to authorize the Foundation to enter

into any contractual or other arrangement inconsistent with any provision of law affecting the issuance or use of patents.

[(b) No officer or employee of the Foundation shall acquire, retain, or transfer any rights, under the patent laws of the United States or otherwise, in any invention which he may make or produce in connection with performing his assigned activities and which is directly related to the subject matter thereof: *Provided, however,* That this subsection shall not be construed to prevent any officer or employee of the Foundation from executing any application for patent on any such invention for the purpose of assigning the same to the Government or its nominee in accordance with such rules and regulations as the Director may establish.]

V. Sectional Analysis of the Bill, H.R. 2066

A bill to authorize appropriations for activities of the National Science Foundation for fiscal year 1984.

Section 2(a).—Authorizes appropriations to the National Science Foundation for fiscal year 1984, in the following categories:

	Thousands
1. Mathematical and physical sciences	$358,600
2. Engineering	121,000
3. Biological, behavioral and social sciences	236,400
4. Astronomical, atmospheric, earth and ocean sciences	329,800
5. U.S. Antarctic program	102,100
6. Scientific, technological and international affairs	36,800
7. Program development and management	66,000
8. Science and engineering education	39,000

Section 2(b).—Requires not less than 15 percent of the sum of the amounts in (a)(1), (a)(2), and (a)(4) to be available for research instrumentation.

Section 2(c).—Requires $23.2 million from the funds in (1), (2), (3), (4) and (7) of (a) to be made available to the STIA directorate over and above the funds authorized in (a)(6).

Section 2(d).—Requires that not less than $8 million shall be available to the Information Science Division.

Section 2(e).—Authorizes an additional appropriation of $50 million for a new initiative in High Technology Research Instrumentation.

Section 3.—Makes appropriations under authority provided sections 2 and 5 available for obligation for time periods specified in the appropriation bill.

Section 4.—Authorizes up to $2,500 for official consultation, representation, or other extraordinary expenses at the discretion of the Director of the Foundation.

Section 5.—Authorizes up to $3.0 million for expenses incurred by the Foundation outside the United States, to be drawn from excess foreign currencies.

Section 6.—States that if the appropriation is less than the total authorized, every program activity, and every floor in the authorization bill, should be reduced by a proportional amount. The only exceptions would be those specified in the appropriations Act.

Section 7.—Permits transfer of funds between the categories in Section 2(a), as long as these do not exceed 10 per centum of the amounts authorized for those categories. Permits the Director of

the Foundation to transfer funds exceeding 10 per centum of the amount authorized for that category, following a written explanation to Congress, and if no objection is made within 30 days.

Section 8(a).—Amends the National Science Foundation Act of 1950 in two places. Changes the text of the original act with respect to special commissions to provide for greater flexibility in using such commissions.

Section 8(b).—Removes unnecessary codification to Resource Centers for Science and Engineering.

Section 8(c).—Deletes disclosure regulation.

Section 8(d).—Deletes provisions banning NSF employees from owning patents resulting from NSF-related work.

VI. Oversight Activities

HEARINGS

Testimony was given by NSF personnel or others on NSF related matters at oversight hearings held by the Committee between April 1982 and March 1983:

National Science Foundation authorization hearings

Posture Hearings—February 23, 1983; Education Programs—February 25, 1983; Astronomical, Atmospheric, Earth and Ocean Sciences Programs—March 1, 1983; Biological, Behavioral, and Social Sciences; Scientific, Technological and International Affairs Programs—March 10, 1983.

Other related hearings

Native Latex Commercialization and Economic Development Act of 1978—March 24, 1983; Earthquake Hazards Reduction Act of 1977—March 15, 1983; Emergency Mathematics and Science Education Act and the National Engineering and Science Personnel Act of 1983—February 9, 16, 1983; Setting Priorities for Science—December 8, 1982; Technology and Handicapped People—September 29, 1982; University/Industry Cooperation in Biotechnology—June 16, 17, 1982; Field Hearings—Secondary Science and Mathematics Education, Norman, Oklahoma, May 7, 1982; and National Engineering and Science Manpower Act of 1982—April 27, 29, 1982.

INSPECTION OF NSF SUPPORTED FACILITIES

NSF projects at the University of Texas at Austin, Tulane University, Florida A&M University, and Florida State University—April 12-16, 1982.

Measurement Systems, Inc. (grantee of NSF Small Business Innovation Research program) at Austin, Texas—April 13, 1982.

Five College Radio Astronomy Observatory, University of Massachusetts—August 31, 1982.

Haystack Radio Observatory, operated by Massachusetts Institute of Technology—September 1, 1982.

Woods Hole Oceanographic Institute and Marine Biological Laboratory—September 3, 1982.

Antarctic research stations—January 11-12, 1983.

ATTENDANCE AT NSF MEETINGS

Committee staff members have attended, or have studied reports of, numerous NSF meetings of the following types: National Science Board meetings, program reviews, program planning sessions, scientific conferences, and advisory committee meetings.

They have also met with NSF personnel on a variety of working topics including: accountability in research and grant management; history, nature, and accomplishment of selected programs; evaluation procedures for grant proposals, amendments to NSF Organic Act, and Directorate-by-Directorate pre-budget reviews of programs, problems, and plans.

GAO REPORTS

The following General Accounting Office reports issued in the past year deal with NSF:

1. "No Federal Programs are Designed Primarily to Support Engineering Education but Many Do," May 14, 1982; PAD-82-20.
2. "Advances in Automation Prompt Concern over Increased Unemployment," May 25, 1982; AFMD-82-44.
3. "NSF's Award of Two Research Vessels Met Requirements," June 28, 1982; PAD-82-14.
4. "National Science Foundation Management Review of Research Grant Award Recommendations," August 26, 1982; PAD-82-49.
5. "NSF Experiment in Research Grant Administration Promising—Changes Needed to Assure Accountability," September 10, 1982; PAD-82-7.
6. "NSF Expenditures for Planning the Overhaul and Conversion of United States Ship Glomar Explorer," March 4, 1983; PLRD-83-47.

VII. Oversight Findings and Recommendations by the Committee on Government Operations

No statement of findings and recommendations on oversight activity pursuant to clause 2(b)(2), rule X and clause 2(1)(3)(D), rule XI, of the Rules of the House of Representatives, have been submitted by the Committee on Government Operations for inclusion in this report.

VIII. Congressional Budget Act Cost Estimate

U.S. Congress,
Congressional Budget Office,
Washington, D.C., April 22, 1983.

Hon. Don Fuqua,
Chairman, Committee on Science and Technology, House of Representatives, Rayburn House Office Building, Washington, D.C.

Dear Mr. Chairman: Pursuant to Section 403 of the Congressional Budget Act of 1974, the Congressional Budget Office has prepared the attached cost estimate for H.R. 2066, the National Science Foundation Authorization Act for Fiscal Year 1984.

Should the Committee so desire, we would be pleased to provide further details on this estimate.

Sincerely,

JAMES BLUM
(For Alice M. Rivlin, Director).

CONGRESSIONAL BUDGET OFFICE COST ESTIMATE

1. Bill number: H.R. 2066.

2. Bill title: National Science Foundation Authorization Act for Fiscal Year 1984.

3. Bill status: As ordered reported by the House Committee on Science and Technology, April 19, 1983.

4. Bill purpose: This bill authorizes the appropriation of $1,343 million to the National Science Foundation (NSF) for fiscal year 1984. Of this amount, $1,301 million is authorized for research and related activities, $39 million is authorized for science and engineering education programs, and $3 million is authorized for the special foreign currency program. Funding levels for certain programs within the research and related activities authorization are also specified.

In addition to these provisions, the bill grants the foundation's director limited authority to transfer funds to other areas, eliminates the requirement that the NSF establish science and engineering resource centers, repeals the section of the NSF Authorization Act of 1978 requiring employee financial disclosures, and repeals the section of the NSF Act of 1950 prohibiting employees from obtaining patents for work performed at the NSF. Section 9 of the bill also establishes rules for appointing and directing special commissions.

The $1,343 million authorized by this bill is $51 million higher than the President's 1984 budget request for the NSF. This figure is $244 million higher than the amount provided to the agency in 1983, largely as a result of additional funds for physical sciences and engineering research.

5. Estimated cost to the Federal Government.

[By fiscal years, in millions of dollars]

	1984	1985	1986	1987	1988
Authorization level	1,343				
Estimated outlays	684	451	124	84	(1)

[1] Less than $500,000.

If outlays from prior year appropriations are included, CBO estimates that 1984 outlays for the NSF programs covered by the bill would total $1,183 million.

The costs of this bill fall within budget function 250.

Basis of estimate: It was assumed for the purposes of this estimate that all amounts authorized will be appropriated and that the funds will be distributed among individual programs as specified in the bill. The estimated level of outlays is based on historical spending patterns for NSF programs.

6. Estimated cost to State and local governments: None.

7. Estimate comparison: None.

8. Previous CBO estimate: On March 30, 1983, CBO prepared a cost estimate on S. 1024 for the Senate Committee on Commerce, Science, and Transportation. That bill authorized 1984 appropriations to the NSF totalling $1,292 million, or approximately $51 million less than H.R. 2066. This cost estimate reflects that difference.

9. Estimate prepared by: Charles Essick.

10. Estimate approved by:

C. G. NUCKOLS
(For James L. Blum,
Assistant Director for Budget Analysis).

IX. IMPACT ON INFLATION

In accordance with clause 2(1)(4), rule XI of the Rules of the House of Representatives, the following statement is made concerning the inflationary impact of H.R. 2066.

H.R. 2066 is assessed to have no inflationary effect on prices and costs in the operation of the national economy.

X. COMMITTEE RECOMMENDATION

A quorum being present, the bill was ordered reported on April 18, 1983 by the Committee by a roll call vote of 27–13.

19-560 O - 83 - 5

XI. Administration Views

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

February 14, 1983

nsf

OFFICE OF THE
DIRECTOR

Honorable Thomas P. O'Neill, Jr.
Speaker of the House of
Representatives
Washington, D.C. 20515

Dear Mr. Speaker:

I am pleased to forward a draft authorization bill for the National Science Foundation for fiscal years 1984 and 1985. Enclosed also is a sectional analysis of the bill.

This draft authorization bill is almost identical to that submitted for fiscal years 1983 and 1984. The amounts recommended for authorization are different, of course, but the only other change is elimination of one of our proposed amendments to the National Science Foundation Act. Section 214 of the recently enacted "Congressional Reports Elimination Act", P.L. 97-375, made the amendment to Subsection 4(j) of the NSF Act that we sought in last year's draft bill.

The Office of Management and Budget has advised us that enactment of the proposed bill would be in accord with the program of the President.

Sincerely yours,

Edward A. Knapp

Edward A. Knapp
Director

Enclosures

Authorization Bill - Fiscal Years 1984 and 1985

Be it enacted by the Senate and the House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National Science Foundation Authorization Act for Fiscal Years 1984 and 1985."

Sec. 2(a) There is authorized to be appropriated to the National Science Foundation $1,289,700,000 for the fiscal year 1984 and such sums as may be necessary for the fiscal year 1985.

(b) Funds authorized for the fiscal year 1984 will be available for the following categories:

(1) Mathematical and Physical Sciences, $364,300,000.

(2) Engineering, $123,000,000.

(3) Biological, Behavioral, and Social Sciences, $223,600,000.

(4) Astronomical, Atmospheric, Earth and Ocean Sciences, $334,900,000.

(5) Antarctic Research Programs, $102,100,000.

(6) Scientific, Technological, and International Affairs, $36,800,000.

(7) Program Development and Management, $66,000,000.

(8) Science and Engineering Education, $39,000,000.

Sec. 3. Appropriations made under authority provided in sections 2 and 5 shall remain available for obligation for periods specified in the Acts making the appropriations.

Sec. 4. From appropriations made under authorizations provided in this Act, not more than $2,500 for fiscal year 1984 and such sums as may be necessary for fiscal year 1985 may be used for official consultation, representation, or other extraordinary expenses at the discretion of the Director of the National Science Foundation. His determination will be final and conclusive upon the accounting officers of the Government.

Sec. 5. Besides the sums authorized by section 2, not more than $2,600,000 for fiscal year 1984 and such sums as may be necessary for fiscal year 1985 are authorized to be appropriated for expenses of the National Science Foundation incurred outside the United States, to be drawn from foreign currencies that the Treasury Department determines to be excess to the normal requirements of the United States.

Sec. 6. Funds may be transferred among the categories listed in section 2(b), so long as the net funds transferred to or from any category do not exceed 10 percent of the amount authorized for that category in section 2. The Director of the Foundation may propose transfers to or from any category exceeding 10 percent of the amounts authorized for that category in section 2. An explanation of any such proposed transfer must be transmitted in writing to the Speaker of the House, the President of the Senate, the Senate Committee on Labor and Human Resources, and the House Committee on Science and Technology. The proposed transfer may be made only when --

(1) thirty calendar days have passed after submission of the written proposal, or

(2) the chairman of the House Committee on Science and Technology and the chairman of the Senate Committee on Labor and Human Resources have each written the Director to the effect that the respective committee has no objection to the proposed transfer.

Sec. 7(a) Section 9 of the National Science Foundation Act of 1950, as amended, is amended to read as follows:

(a) Each special commission established under section 4(h) shall be appointed by the Board and shall consist of such members as the Board considers appropriate.

(b) Special commissions may be established to study and make recommendations to the Foundation on issues relating to research and education in science and engineering.

(b) Section 6 of Public Law 95-99, the National Science Foundation Authorization Act for FY 1978, is deleted and the sections following it all renumbered accordingly.

(c) Section 10 of Public Law 95-99, the National Science Foundation Authorization Act for FY 1978, is deleted.

(d) Subsection 12(b) of the National Science Foundation Act of 1950, as amended, is deleted and the preceding subsection is redesignated by striking the "(a)".

Section 7 of NSF FY 1984-1985 Authorization Bill:

Proposed Changes to National Science Foundation Act of 1950

The submitted bill would make four amendments to the National Science Foundation Act and related laws. All the proposed changes would serve a broad long-term purpose. They represent a continued collaboration between the Foundation and the congressional committees charged with oversight of its activities to simplify and streamline its organic legislation. This effort serves two major purposes:

1. It provides NSF officials, members of the public, and Members of the Congress a clear, uncluttered, and current congressional statement of the Foundation's mission, functions, and operations. This allows clearer understanding and sharper focus on significant policy issues.

2. It contributes to current deregulatory efforts of the Congress. Although most deregulatory efforts focus on alleviating burdens on the private sector, even where removal of restrictions directly affects only a Federal agency such as the Foundation, there is a positive effect. Government agencies suffer from inflexibility and misdirected effort brought on by outdated or unnecessary regulation just as individuals and business firms do. Deregulation requires that codified laws and regulations be made to contract where possible, instead of only expanding.

Proposed Change #1. "Section 9 of the National Science Foundation Act of 1950, as amended, is amended to read as follows:

(a) Each special commission established under section 4(h) shall be appointed by the Board and shall consist of such members as the Board considers appropriate.

(b) Special Commissions may be established to study and make recommendations to the Foundation on issues relating to research and education in science and engineering."

Explanation of Proposed Change #1. Section 4(h) of the National Science Foundation Act authorizes the National Science Board to establish "special commissions" from time to time as it may deem necessary for the purposes of the NSF Act. Such a commission can be a useful means of focusing the attention of distinguished scientists and other citizens on specific problems relating to science. However, limitations on the composition and duties of special commissions imposed in section 9 of the Act have unfortunately limited their value and therefore their use.

Section 9(b) of the NSF Act restricts any special commission to making a "comprehensive survey of research" and formulating and recommending to NSF an "over-all research program" for a particular scientific field of study. The Foundation believes that special commissions would be more helpful and used more often if the commissions' writs could be drawn more broadly. The proposed amendment would authorize the Board to establish special commissions to study and make recommendations on any issues relating to the principal areas of responsibility of the National Science Foundation.

SECTIONAL ANALYSIS - NSF FY 1984-1985 Authorization Bill

A bill to authorize appropriations for activities of the National Science Foundation, and for other purposes.

Sec. 1. Permits the citation of the Act as the "National Science Foundation Authorization Act for Fiscal Years 1984 and 1985."

Sec. 2. Authorizes appropriations in eight activities totaling $1,289,700,000 for FY 1984 and such sums as may be necessary for FY 1985.

Sec. 3. Provides that appropriations made under sections 2 and 5 remain available for periods specified in appropriations acts.

Sec. 4. Authorizes expenditures of up to $2,500 for FY 1984 and such sums as may be necessary for FY 1985 for official consultation, representation, and other extraordinary expenses at the discretion of the Director.

Sec. 5. Authorizes, besides the appropriations in section 2, an appropriation not to exceed $2,600,000 for FY 1984 and such sums as may be necessary for FY 1985, for expenses of the National Science Foundation incurred outside the United States to be drawn from excess foreign currencies.

Sec. 6. Provides that funds may be transferred among categories but precludes transfers to or from any category exceeding 10 percent of the amount listed for that category until either:

(A) thirty calendar days have passed after the Director has notified the Speaker, the Vice President, and the Senate and House authorization committees of the nature of the transfer and the reason for it, or

(B) both authorization committees have written the Director that they have no objection to the transfer.

Sec. 7. Makes several amendments to the NSF Act.

Section 9(a) restricts the membership of any special commission to six scientists and five non-scientists. Though this may be a good number and a good distribution for many cases, it is extraordinarily rigid. In many cases it would prevent selection of the best mix of scientists who are experts or specialists in the issues to be addressed, scientists who are not specialists in those issues, and nonscientists. The proposed amendment would allow the Board discretion to take account of the subject and the circumstances in fixing the size of a special commission and determining its composition.

No significant increase in cost or personnel will result if the proposal is enacted. Moreover, most, if not all, special commissions established would be considered to be subject to the requirements of the Federal Advisory Committee Act.

Proposed Change #2. "Section 6 of Public Law 95-99, the National Science Foundation Authorization Act for FY 1978, is deleted and the sections following it all renumbered accordingly."

Explanation of Proposed Change #2. Section 6 of P.L. 95-99 directed the Foundation to establish a Resources Center for Science and Engineering to be located at an educational institution. Four such centers have been funded.

This section of the Foundation's annual authorization act was permanently codified in the U.S. Code as 42 U.S.C. §1884, apparently as a matter of codification committee routine. The Foundation sees no reason for this codification. No other specific programs of the Foundation initiated at the direction of the Congress have been permanently codified. Moreover, authority for establishing such centers is now covered under the Science and Technology Equal Opportunities Act (42 U.S.C. §§1885-1885d), making this section redundant. Deletion of the section will simplify the law.

No increase in cost or personnel will result if the proposal is enacted.

Proposed Change #3. "Section 10 of Public Law 95-99, the National Science Foundation Authorization Act for FY 1978, is deleted."

Explanation of Proposed Change #3.

This lengthy provision, codified as 42 U.S.C. §1873a, was added in 1977 to require NSF employees to disclose any financial interests or academic affiliations that might bear on their handling of proposals or other applications. It also required that the NSF adopt implementing regulations. It is unique, as no other agency of the Federal Government is subject to specific statutory requirements in this area. The broader disclosure requirements of the Ethics in Government Act are binding on all agencies, including the NSF. (In fact, under subsection (d), §1873a(d), most of this section was superseded by the Ethics in Government Act.) Moreover, all agencies are required by Executive Order 11222 to maintain conflict-of-interests regulations that deal with any problems unique to their programs and methods of operation.

The Foundation's conflict-of-interest regulation was extensively revised last July (45 CFR Parts 680 through 684; published in the Federal Register, Vol. 47, No. 143, July 26, 1982, on pages 32130 through 32153). The new regulation requires both disclosure of all potentially biasing affiliations or relationships and special oversight in cases involving them, with further special handling if necessary (45 CFR Part 681). The statutory provision is thus no longer necessary, and its deletion would simplify the law and allow more scope for future evolution of NSF policy in this area.

No increase in cost or personnel will result if the proposal is enacted.

Proposed Change #4. "Subsection 12(b) of the National Science Foundation Act of 1950, as amended, is deleted and the preceding subsection is redesignated by striking the '(a)'."

Explanation of Proposed Change #4.

Subsection 12(b) of the NSF Act, codified as 42 U.S.C. §1871(b), bans an NSF employee from owning a United States patent on any invention made in connection with and directly relating to the subject matter of his or her assigned duties.

The Foundation is believed to be the only Federal agency to have a statutory provision governing the allocation of rights to inventions made by its employees. All other agencies are governed by Executive Order 10096, as amended, which permits Federal employee-inventors to retain principal patent rights to their invention under certain circumstances. (See Section 1(c) of E.O. 10096 and the implementing regulations of the Patent and Trademark Office published at 37 CFR Part 100.) No reason is known for this special restriction on the Foundation's employees. The provision probably resulted from a general congressional concern over the treatment of Federal employees' inventions, which President Harry Truman assuaged by issuing E.O. 10096 in January 1950, just four months before the NSF Act became law.

As far as can be determined, the provision has had no actual effect on the Foundation's employees. The NSF, after all, performs no "in-house" research that could produce inventions. Only one invention has ever been reported by a Foundation employee.

Deletion of this provision would simplify the law and remove an inequitable distinction between the Foundation's employees and those of other Federal agencies.

No increase in cost or personnel will result if the proposal is enacted.

XII. BUDGET AS REQUESTED

National Science Foundation

Washington, D.C. 20550

FY 1984

Budget Summary

to the Congress

NEW OBLIGATIONAL AUTHORITY

FY 1984 Budget Request	$1,292,300,000
FY 1983 Appropriation (P.L. 97-272)	1,092,200,000
Proposed Supplemental Appropriation Request	1,700,000
FY 1983 New Obligational Authority	1,093,900,000
Increase in New Obligational Authority FY 1984/FY 1983	198,400,000

Program Level

FY 1984	$1,292,300,000
FY 1983:	
Appropriation	1,092,200,000
Plus Proposed Supplemental Appropriation Request	1,700,000
Plus Carryover	3,265,396
FY 1983 Program Level	1,097,165,396
Increase in Program Level FY 1984/1983	$195,134,604

NATIONAL SCIENCE FOUNDATION

FY 1984 BUDGET

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Appendix A-Grants and Contracts Awarded FY 1981: Part IV

NATIONAL SCIENCE FOUNDATION
TOTAL DOLLAR SUMMARY
FY 1982—FY 1984

(Millions of Dollars)

	Actual FY 1982	*Request FY 1983*	*Current Plan FY 1983*	*Estimate FY 1984*	*Difference FY 1984/83*
Appropriation	$1,037.0	$1,072.8	$1,093.9	$1,292.3	$198.4
Less Reductions	-41.4	—0—	—0—	—0—	—0—
Net Appropriation	995.6	1,072.8	1,093.9	1,292.3	198.4
Carryover	2.3	—0—	3.3	—0—	-3.3
Recoveries	5.0	—0—	—0—	—0—	
Total Availability	1,002.9	1,072.8	1,097.2	1,292.3	195.1
Obligations	999.1	1,072.8	1,097.2	1,292.3	195.1
Lapse	.5	—0—	—0—	—0—	—0—
Carry Forward	3.3	—0—	—0—	—0—	—0—

EXPLANATION OF PRIOR YEAR CARRYOVER

In addition to the FY 1983 appropriation, an unobligated balance of $3,265,396 prior year appropriation is available for obligation in FY 1983. The distribution of these funds is as follows:

- o No-Year Funds - Prior to FY 1974, NSF appropriations were made on a no year basis and unobligated balances are available until expended. The $76,042 available from the closeout of completed awards will be used in NSF Planning and Evaluation to support priority projects not included in the FY 1983 Request.

- o Program Development and Management - The unobligated balance of $331,404 from the FY 1982 Research and Related Appropriation will be used to partially offset a shortage in personnel compensation and benefits, resulting from the $700,000 reduction in Program Development Management from the original NSF request.

- o Program Funds - The unobligated balance from program funds is $1,939,883. Of this amount, $1,868,695 was allocated to fund projects for which committments were made in FY 1982 but not actually obligated prior to the end of the fiscal year. The amounts are as follows:

  Mathematical and Physical Sciences, $683,437; Astronomical, Atmospheric, Earth and Ocean Sciences, $776,368; and Biological, Behavioral, and Social Science, $408,890. The remaining balance of $71,188 will be used in the Scientific, Technological and International Affairs, for funding additional new high priority planning projects.

- o Special Foreign Currency - These funds amounting to $918,067 from FY 1982 appropriation will be utilized in the FY 1983 program.

NATIONAL SCIENCE FOUNDATION

SUMMARY OF FY 1984 BUDGET BY APPROPRIATION AND PROGRAM

	Actual FY 1982	*Request FY 1983*	*Current Plan FY 1983*	*Estimate FY 1984*	*Difference FY 1984/83*
Research and Related Activities Appropriation					
Mathematical and Physical Sciences	$272,842,614	$298,700,000	$299,716,437	$364,300,000	$64,583,563
Engineering	93,285,529	99,700,000	100,800,000	123,000,000	22,200,000
Biological, Behavioral and Social Sciences	176,597,165	186,700,000	190,242,890	223,600,000	33,357,110
Astronomical, Atmospheric, Earth and Ocean Sciences	259,852,856	273,700,000	276,109,368	334,900,000	58,790,632
U.S. Antarctic Program	68,504,786	86,400,000	83,200,000	102,100,000	18,900,000
Scientific, Technological and International Affairs	40,324,426	44,000,000	44,166,230	36,800,000	-7,366,230
Minority Institutions Science Improvement Program	—0—	3,287,000	—0—	—0—	—0—
Program Development and Management	63,182,341	63,081,000	65,312,404	66,000,000	687,596
Undistributed	—0—	—0—	4,500,000	—0—	-4,500,000
Subtotal, Obligations	974,589,717	1,055,568,000	1,064,047,329	1,250,700,000	186,652,671
Funding Reconciliation					
Unobligated Balances Brought Forward	-771,109	—0—	-2,347,329	—0—	2,347,329
Unobligated Balance Carried Forward	2,347,329	—0—	—0—	—0—	—0—
Adjustments to Prior Year Accounts	-5,030,809	—0—	—0—	—0—	—0—
Unobligated Balance Lapsing	459,872	—0—	—0—	—0—	—0—
Research and Related Activities Appropriation	971,595,000	1,055,568,000	1,061,700,000	1,250,700,000	189,000,000
Science and Engineering Education Activities Appropriation					
Graduate Research Fellowships	[14,999,999]	[15,000,000]	15,000,000	19,000,000	4,000,000
Pre-College Teacher Improvement in Science and Mathematics	—0—	—0—	15,000,000	20,000,000	5,000,000
Scientific Personnel Improvement	16,745,101	15,000,000	—0—	—0—	—0—
Science Education Development and Research	2,672,106	—0—	—0—	—0—	—0—
Science Education Communication	1,186,357	—0—	—0—	—0—	—0—
NSB Commission on Pre-College Education	293,672	—0—	—0—	—0—	—0—
Subtotal, Obligations	20,897,236	15,000,000	30,000,000	39,000,000	9,000,000
Funding Reconciliation					
Unobligated Balance Lapsing	2,764	—0—	—0—	—0—	—0—
Science and Engineering Education Activities Appropriation	20,900,000	15,000,000	30,000,000	39,000,000	9,000,000
Special Foreign Currency Appropriation					
Research and Related Activities	3,654,702	2,200,000	3,118,067	2,600,000	-518,067
Subtotal, Obligations	3,654,702	2,200,000	3,118,067	2,600,000	-518,067
Funding Reconciliation					
Unobligated Balance Brought Forward	-1,550,334	—0—	-918,067	—0—	918,067
Unobligated Balance Carried Forward	918,067	—0—	—0—	—0—	—0—
Adjustments to Prior Year Accounts	2,585	—0—	—0—	—0—	—0—
Unobligated Balance Lapsing	55,000	—0—	—0—	—0—	—0—
Special Foreign Currency Appropriation	3,080,000	2,200,000	2,200,000	2,600,000	400,000
TOTAL NSF APPROPRIATIONS	995,575,000	1,072,768,000	1,093,900,000	1,292,300,000	198,400,000

OVERVIEW AND HIGHLIGHTS

Introduction

The achievement of our National goals in the decade of the 1980s -- sustained, real economic growth; enhanced national security; and improved quality of life for all citizens -- depends on the discovery of new scientific knowledge, the development of new technologies, and the production of trained scientists and engineers. All of these flow from our investment in fundamental research on the Nation's university and college campuses. While no one can foresee the exact problems or needs that this country will face tomorrow, we can be confident that basic scientific and engineering knowledge will lay the groundwork for addressing them and that trained scientists and engineers will be essential to solving them.

The major domestic challenge facing the United States in the 1980s and beyond is to put the economy on a firm footing of stable, continuing growth through increased employment, improved productivity, and strengthened international competitiveness of American technology, products and services. The Nation's science and technology base -- and the pool of scientific and technical personnel which the Foundation's programs of basic academic research produce and support -- will play a critical role in achieving this aim.

The Budget Request of the National Science Foundation for FY 1984 reflects the central importance of this role and also recognizes the challenge involved in placing excellence at the forefront of the Nation's agenda for fundamental research, precollege science and mathematics education, and the training of future scientists, engineers and technical personnel. It does this in three important ways:

- o First, it requests an increase of 17.8 percent above the FY 1983 Current Plan. Within this total, support for the conduct of basic research is 18.3 percent above the amount estimated for FY 1983 -- a significant step in the direction of restoring the vitality, strength, and overall quality of the science and technology enterprise in the Nation's universities and colleges. The increase will provide expanded levels of support for the Nation's most gifted researchers and graduate students and for research instrumentation. These funds will strengthen the scientific and technical knowledge base upon which our future depends and help train the strong scientific and engineering corps to staff our changing industrial and educational system.

- o Second, it contains three significant Presidential Initiatives. These are aimed at recognizing and encouraging the most outstanding young scientists and engineers to pursue the academic research careers for which they are especially gifted -- and from which the Nation has so much to benefit -- and at restoring quality to the teaching of science and mathematics in the Nation's secondary schools.

- Finally, to further the emphasis on scientific excellence and technological and economic pertinence, this budget request introduces a management philosophy and practice that integrates research programs targeted at selected groups and institutions into the mainstream of the Foundation's research activities. This is accomplished by assigning to the Foundation's major research programs -- and the Program Officers who direct them -- budgetary and direct management responsibility for all aspects of the future health and vitality of their respective disciplines. At the same time, coordinating responsibilities of the Scientific, Technological, and International Affairs (STIA) Activity are strengthened and increased.

The requested rate of growth in the Foundation's budget over previous fiscal years, in a period of economic and budgetary uncertainties reflects two primary facts: (i) the importance which the President attributes to basic research for laying the groundwork of economic recovery and long-term economic growth, and for providing the foundation for the technologies on which our national security and other national objectives depend; and (ii) recognition of the need to revitalize the research base in the Nation's universities and colleges in order to ensure a continuing ability to produce the world-class scientists and engineers needed in the years ahead.

The Federal Role in Basic Research

In FY 1982 the Federal Government provided about $5.3 billion, or almost 67 percent of the total national investment in basic research. In the same year, the industrial sector accounted for approximately 17 percent of the total, a fraction that has declined since the early 1960s when industrial funding constituted about 28 percent of total investment in basic research. The remaining basic research funds were provided by the academic sector (10 percent) and nonprofit institutions (6 percent).

Since the 1950s, the rationale for Federal investment in fundamental research in science and engineering has been well developed and is now generally accepted. Federal support of such research is justified when the Government itself is a direct user of the results, as in the case of national defense, or when important, broad areas of high risk science and engineering research would be underfunded, in terms of their potential long-term payoff, by the private sector. It is this latter research which provides much of the knowledge base upon which solutions to our current and future economic, social and technological problems, many currently unforeseen, will ultimately depend. This is where the activities of the NSF make their contributions to the Nation.

The NSF Role in Research

In FY 1982 the National Science Foundation's basic research obligations of $911.0 million accounted for almost one-fifth of the total Federal support of basic research. This represents 26 percent of the Federal support for basic research carried out in the Nation's colleges and universities and thus has a significant impact on the training of the next generation of scientists and engineers.

NSF programs are responsive to the "intellectual marketplace" of ideas arising from the activities and interests of scientists and engineers in the Nation's universities, colleges, and other research institutions. In addition, they are designed in light of the basic research programs of mission agencies. The Foundation's proposal review system is a competitive, national evaluation of research ideas, designed to select and fund those projects of the highest scientific promise. The system allows for a free flow of ideas and basic discoveries and enables the Foundation to adjust its plans and priorities to take advantage of emerging -- and sometimes unanticipated -- research opportunities.

The NSF provides support for the tools and research facilities that permit significant scientific advancement in many disciplines. This support ranges from purchases of equipment in individual research projects, to the support of major user facilities in physics and materials research, the academic research fleet in oceanography research, five national astronomy centers and a national atmospheric research center. In addition, the Foundation funds and manages the U.S. Antarctic Program, the principal expression of active U.S. interest in that continent under the Antarctic Treaty.

NSF programs are particularly important for the academic sector. In some fields, such as the geological sciences, mathematics, ground-based astronomy, anthropology and ecology, NSF supported from 50 to over 90 percent of the basic research conducted in academic institutions in FY 1982. In other fields, such as chemistry, economics, electrical engineering and some parts of physics, the Foundation provided one-third to two-fifths of the available funding. These data illustrate the breadth and significance of NSF's responsibilities in university-based research.

A critical features of this pattern of NSF support of basic research in universities and colleges is that it ensures that the research function is clearly linked with the education of future scientists and engineers. As a result of their research in science and engineering, faculties stay at the forefront of scientific and technical knowledge. Graduate and undergraduate students are integral to this research process which generates new knowledge. Later, these students, in turn, bring their knowledge to work in academia, industry or the governmental research laboratory.

Graduate students are supported in NSF-funded research projects through research assistantships on the basis of merit and the congruence of student and faculty research interests and abilities. In this apprenticeship role, they perform a vital function in the conduct of academic research and, most importantly, infuse a vitality and fresh perspective in this research which is critical to its quality and innovativeness.

NSF FY 1984 Budget Request

The Foundation's FY 1984 Budget Request totals $1,292.3 million, an increase of $195.6 million or 17.8 percent above the FY 1983 Current Plan of $1,096.7 million. It includes $1,250.7 million for Research and Related Activities, $39.0 million for two Presidential Initiatives in precollege science and mathematics education and graduate research fellowships, and $2.6 million in Special Foreign Currency.

Several underlying principles and strategies were used to determine the allocations reflected in the FY 1984 budget request.

First, emphasis is placed on maintaining scientific excellence by ensuring that adequate resources are available to pursue aggressively the most promising and exciting research opportunities. The requested increase will be used to expand support for the very best scientific and engineering researchers. This expanded support might take various forms: increased or refurbished research instrumentation; additional, or improved, regional or central research facilities; acceleration of existing thrusts or initiation of new research thrusts in areas of particular scientific promise and need such as mathematics, plant biology, or parts of the earth sciences; increased support for young investigators or graduate research assistants to encourage them to pursue research careers either in academia or industry, depending on the particular needs and structures of the different disciplines which the Foundation supports.

Second, a broad base of support for all disciplines is maintained. This underlines the fact that each field which the Foundation supports helps maintain the broad knowledge, technology, and technically trained manpower base upon which this country's future depends. In the absence of certainty about where the next technological or scientific breakthroughs are most likely to occur or which particular technological developments will be required by our economy and society in the future, support of a broad and vigorous research enterprise is in our Nation's best interests.

Finally, the Foundation has, in the past, supported and managed a number of important activities, independently of its major scientific and engineering programs. These include research projects funded under bilateral agreements, programs to strengthen the research capabilities of faculty in our leading undergraduate colleges, and programs to provide incentives for women and minorities to pursue research careers. In an effort to strengthen and expand these critical facets of the health of science and engineering, the decision has been made to integrate them directly into the Foundation's mainline research activities. This involves a substantial broadening of the responsibilities of the Foundation's program officers in the research activities and the parallel strengthening of the coordination responsibilities of the staff of the STIA Activity.

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Programmatic Objectives and Highlights of the FY 1984 Request

In FY 1984, the Foundation's budget request is organized around nine budget activities.

Four of these are structured around science and engineering disciplines, together with the facilities and operations required for research in these disciplines: Mathematical and Physical Sciences; Engineering; Biological, Behavioral, and Social Sciences; and Astronomical, Atmospheric, Earth, and Ocean Sciences. These activities carry heightened responsibilities to enhance the research vitality of the Nation's leading undergraduate colleges; implement programs to improve the quality and attractiveness of academic research career opportunities for women, minorities and young scientists and engineers; and encourage research support provided under various bilateral agreements.

The U.S. Antarctic Program represents the sole U.S. presence in Antarctica under the Antarctic Treaty.

The Scientific, Technological and International Affairs Activity includes a variety of responsibilities that cut across scientific and engineering disciplines, and provide services to the scientific community. These include science policy research, international scientific activities, monitoring the state of scientific and technical personnel in the Nation, industry/university cooperative projects, and support of research by small businesses.

The Science and Engineering Education Activity consists of two Presidential Initiatives aimed at improving the quality of education in mathematics and science in the Nation's secondary schools and a graduate fellowship program which provides stipends and cost-of-education allowances to highly talented graduate students who are selected in a national competition.

The Program Development and Management activity provides the resources such as salaries, travel, equipment, rent, and communications necessary to conduct the Foundation's day-to-day business.

The Special Foreign Currency activity supports scientific research and related efforts in selected countries where foreign currencies owned by the United States are designated as excess to Federal requirements.

The objectives and highlights of each budget activity follow.

MATHEMATICAL AND PHYSICAL SCIENCES (MPS)

The objective of the Mathematical and Physical Sciences (MPS) activity is to increase fundamental understanding of the physical laws that govern the world and the universe in which we live. MPS uses a wide range of research support modes, including individual or group research projects, special instrumentation grants, university research laboratories and national user facilities. Support is provided for research in mathematics, computer science, physics, chemistry, and materials research.

The FY 1984 Budget Request for this activity is $364.3 million, an increase of $64.6 million or 21.5 percent above the Current Plan for FY 1983 of $299.7 million. This substantial increase is intended to strengthen and revitalize academic research by:

- Providing enhanced support and improved opportunities for graduate students, postdoctoral scientists, and young faculty investigators.

- The MPS total for all categories of research instrumentation and equipment is increased by $29.9 million or 53.0 percent, to a total of $86.3 million. Support for acquisition of equipment in the intermediate cost category (between that normally provided in research awards and that made available through major laboratories and national facilities) is increased by $7.7 million, or 61.1 percent, to a total of $20.3 million.

- Providing additional support for research using the Cornell accelerator and for university-based research to be performed with the new Tevatron at Fermi National Accelerator Laboratory.

- Increasing the size of research awards to provide the resources necessary to conduct high quality research programs, with emphasis on improved experimental capability. In chemistry, for example, project support will be increased 15.1 percent, or by $8.1 million, to $61.9 million to revitalize and accelerate promising experimental research programs. Similar increases are provided in research awards for mathematics, computer research, and materials research.

- Continuing the planned development of modern experimental research facilities for computer research by adding 4 to 5 new facilities to bring the total of university centers to 18-19.

- Increasing the provision of equipment for scientific computing and providing improved access to modern computational facilities to all the MPS disciplines. An increase of $5.0 million is planned for this thrust beyond that provided in computer research programs.

ENGINEERING (ENG)

The objectives of the Engineering activity are to (i) advance fundamental knowledge of engineering principles that can be applied to the analysis and design of man-made devices, systems and processes; (ii) focus research attention in areas relevant to selected national problems; and (iii) strengthen the academic research base of the engineering research community through expanded support of the most promising young investigators and graduate students. While this activity provides some support for selected research facilities, it primarily funds individual research projects, including a special research initiation program for young investigators. It also works in close cooperation with the University/Industry Cooperative Research program supported under the Scientific, Technological and International Affairs (STIA) activity.

The FY 1984 Budget Request for this activity is $123 million. This represents an increase of $22.2 million or 22 percent above the FY 1983 Current Plan of $100.8 million. Within this amount:

- Support for young faculty members and engineering graduate students is expanded.
- Emphasis is placed on research in microelectronics and on work related to automated manufacturing, robotics, biotechnology and the development of novel chemical and separation processes central to chemical process technology.
- Support of research in geotechnical engineering, structural mechanics, and water resources and environmental engineering is increased by over 21 percent and earthquake research is increased by over 9 percent.
- Provision is made for larger awards, including additional funding for research and equipment, expanded support for research initiation grants for young faculty, and continued opportunities for interdisciplinary research.

BIOLOGICAL, BEHAVIORAL AND SOCIAL SCIENCES (BBS)

The objective of the Biological, Behavioral and Social Sciences Activity is to increase basic understanding of life forms and life processes. It supports individual research projects ranging from studies of fundamental molecules of living organisms to studies of the complex interrelationships between human populations and their institutions.

The FY 1984 Budget Request is $223.6 million, an increase of $33.4 million or 17.5 percent above the FY 1983 Current Plan of $190.2 million. Within the amount requested:

- Physiology, Cellular and Molecular Biology, which is increased $17.2 million (or 20.1 percent) over the FY 1983 Current Plan, will have four emphases: bringing support of the highest quality projects up to their optimal levels; providing sophisticated instrumentation; enhancing research in plant biology, with special attention to young investigators; and meeting scientific opportunities arising from new developments in genetics.
- The increase of $7.8 million, or 17.1 percent, for Biotic Systems and Resources over the FY 1983 Current Plan will allow special emphasis on research awards for young investigators; refurbish research equipment and facilities at marine laboratories; and meet special opportunities in plant biology.
- In Behavioral and Neural Science, the major part ($3.0 million) of the requested increase of $4.1 million over the FY 1983 Current Plan

will be used to expand neuroscience research where increasingly sophisticated instrumentation and techniques allow investigation of the nervous system in detail. Special scientific areas include sensory transduction, nervous system repair mechanisms, and the molecular basis of neuronal interactions. The remaining increase of $1.1 million will permit emphasis on important research areas in anthropology and the cognitive sciences.

- In the Social and Economic Sciences, most of the increase of $3.5 million (or 17.7%) over the FY 1983 Current Plan will be used to develop major social science data bases, such as the General Social Survey, and for methodological research to improve the scientific usefulness of these resources.

- Information Science and Technology, with its 13.0 per cent ($0.7 million) increase over the FY 1983 Current Plan, will place additional emphasis on expanded fundamental knowledge of information science to improve and make optimal use of information resources.

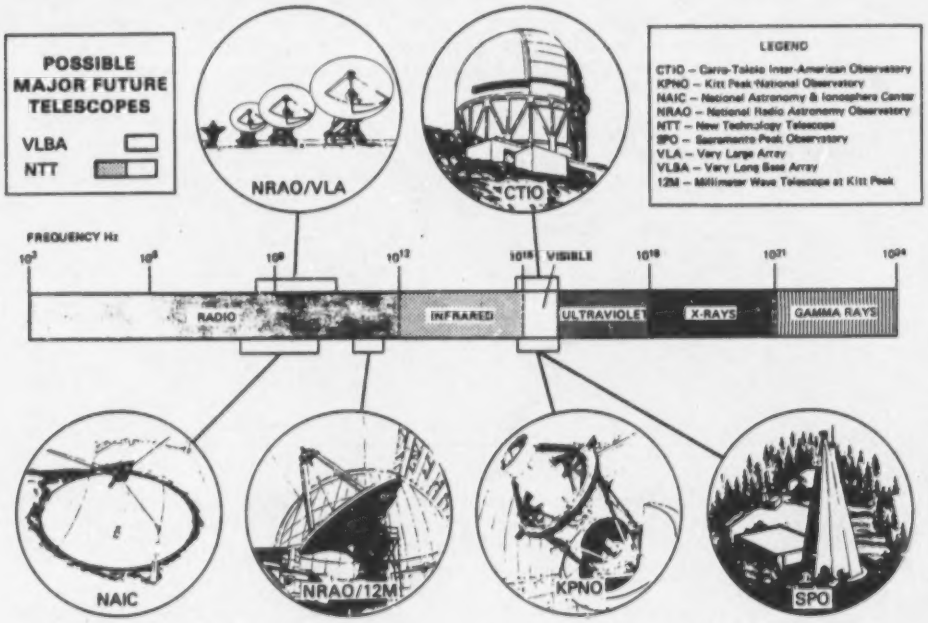
ASTRONOMICAL, ATMOSPHERIC, EARTH AND OCEAN SCIENCES (AAEO)

The objectives of the Astronomical, Atmospheric, Earth and Ocean Sciences activity are to (i) increase understanding of the physical nature of the universe; (ii) advance knowledge of the earth's atmosphere; (iii) provide further insights into the physical and chemical composition of the earth and its geologic history; (iv) improve knowledge of the world's oceans, and sea floor, and (v) advance knowledge of natural phenomena in the Arctic. The activity directly supports individual investigators; it also supports major research facilities, including the National Center for Atmospheric Research and the National Astronomical Observatories.

The FY 1984 Budget Request for the AAEO activity is $334.9 million, an increase of $58.8 million or 21.3 percent above the FY 1983 Current Plan of $276.1 million. This provides for:

- A special emphasis in Astronomy to begin implementing the most important recommendations of the report of the Astronomy Survey Committee of the National Academy of Sciences. This includes improved instrumentation at universities and national centers, and feasibility and design studies on the Very Long Baseline Array (VLBA) to provide a basis for future consideration of NSF funding of this project. The accompanying illustration shows the portions of the electromagnetic spectrum in which observations can be made by instruments at the National Astronomy centers.

SPECTRUM COVERAGE OF TELESCOPES AT NATIONAL ASTRONOMY CENTERS



- An increase in Atmospheric Sciences for further upgrading of the computing facility at the National Center for Atmospheric Research with the purchase of a new mass storage system and project support increases in all subdisciplines, particularly in atmospheric chemistry.

- An additional increase in Earth Sciences that allows year-round continental reflection profiling operations, major upgrading of instrumentation and a major research thrust on the evolution and structure of the continental crust.

- Increased support for ocean sciences research on crustal studies, particularly work related to the continental thrust in the Earth Science subactivity.

- An increase of $9.8 million from $16,500,000 to $26,300,000 in FY 1984 to allow for continuation of the Deep Sea Drilling Project. Early in FY 1983, NSF established a committee of distinguished earth and ocean scientists to review all aspects of crustal research. This

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committee will examine the long-term needs and priorities related to such research and make recommendations on how available funds for crustal research can be used most effectively in the future.

U.S. ANTARCTIC PROGRAM (USAP)

The National Science Foundation has been responsible for managing and funding the U.S. Antarctic Program since 1972. The President and the Congress have recognized that this responsibility is in addition to the usual activities of NSF. U.S. policy calls for the maintenance of an active, national presence in Antarctica. The accompanying map shows major stations of the U.S. and other countries. Support of scientific research has been the principal expression of this presence, which includes:

- Two coastal and two inland stations manned year-round, including the South Pole station.
- A substantial logistic system, including a dedicated, heavy airlift capability, support and staging bases, and U.S. Coast Guard icebreaker support.
- A balanced, multi-disciplinary research program with significant international cooperation.

The FY 1984 Budget Request for the U.S. Antarctic Program activity is $102.1 million. The increase for support of this activity is $18.9 million or 22.7 percent above the FY 1983 Current Plan of $83.2 million. This increase in FY 1984 will allow:

- Two major capital investment projects totalling $10.8 million -- $5.8 million to replace a large vehicle maintenance facility destroyed by a fire in December, 1981 and $5.0 million to initiate a Service Life Extension Program (SLEP) on the two oldest LC-130 ski-equipped Hercules aircraft.
- A 9.6 percent increase in the Operations Support Program to offset several years of price increases and resume the equipment procurement, facilities upgrading, and maintenance projects that have been deferred in FY 1983 and prior years.
- The $1.0 million increase for research projects will allow increased emphasis in all research areas.

ANTARCTICA: selected stations and physical features.

SCIENTIFIC, TECHNOLOGICAL AND INTERNATIONAL AFFAIRS (STIA)

The Scientific, Technological, and International Affairs Activity includes a variety of responsibilities that cut across the Foundation's scientific and engineering disciplines. Prominent among these is a new Presidential initiative to support the Nation's brightest young science and engineering faculty to encourage them to pursue academic careers. Other activities include cooperative research that links academic research performers with industrial and small business researchers; the facilitation of international scientific research cooperation and the exchange of scientific and technical information; the provision of data and analysis on scientific personnel, national R&D activities, and science and technology policy issues of national importance; and strengthening the Nation's research base by expanding opportunities for all qualified segments of the scientific community to contribute to high quality research.

The FY 1984 Budget Request incorporates a new philosophy and practice of management. This new philosophy is most clearly reflected in the STIA activity. As the table below indicates, some budgetary responsibility, as

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well as responsibility for management and coordination of the indicated programs, remains in STIA. However, decision-making responsibility and budgetary support in the targeted amounts shown in the table will be provided within the appropriate Foundation research programs. In the FY 1984 Budget Request, the amounts shown for international cooperative research; undergraduate college research support; visiting professorships for women; and experimental program to stimulate competitive research will constitute funding floors. The total amounts finally obligated in all of these programs will depend on the quality of the proposals received and here, as elsewhere in the Foundation's programs, the intent will be to improve the quality of the Nation's science and technology base by supporting the very best investigators and research opportunities.

NATIONAL SCIENCE FOUNDATION

PROGRAMS COORDINATED BY STIA THAT RECEIVE PARTIAL OR TOTAL FUNDING WITHIN THE RESEARCH ACTIVITIES

(In Millions of Dollars)

Program	FY 1983 Current Plan	FY 1984 STIA	FY 1984 Funding Within Research Activities	FY 1984 Estimated Total	Change FY 84/FY 83
International Cooperative Research Activities	$ 9.9	$5.0	$ 5.9	$10.9	10.1%
U.S.-India Joint Program	—0—	—0—	2.0	2.0	New Program
Presidential Young Investigators Research Awards	—0—	—0—	6.0	6.0	New Program
Undergraduate College Research Support	—0—	—0—	3.0	3.0	New Program
Visiting Professorships for Women	1.5	1.0	0.5	1.5	—0—
Experimental Program to Stimulate Competitive Research	2.5	—0—	2.5	2.5	—0—
NSF Planning & Evaluation	2.7	—0—	2.0	2.0	-25.9%
Waterman Award	.2	—0—	.2	.2	—0—
TOTAL	$16.8	$6.0	$22.1	$28.1	67.5%

The new management philosophy for these programs represents a substantial broadening of the responsibilities of the Foundation's discipline-oriented program officers and a concomitant strengthening of the coordinative responsibilities of the STIA staff. It is anticipated that this approach will increase not only the quality and scientific pertinence of these programs, but also eventually expand support for the most worthy ones as they become integrated into the mainstream of the Foundation's research activities.

In FY 1984, a new subactivity, Research Initiation and Improvement (RII), is begun under the STIA activity. This new subactivity combines the programs previously supported under the Coordinated Agency-Wide Research Activity (CARA) subactivity with program elements formerly shown under (i) the Intergovernmental and Public Service Science and Technology subactivity and (ii) the Ethics and Values in Science and Technology program element in the Policy Research and Analysis subactivity.

The FY 1984 Budget Request for STIA is $36.8 million, an apparent decrease of $7.4 million below the FY 1983 Current Plan of $44.4 million. As the table shows, however, an estimated $22.1 million within the Foundation's discipline

oriented research activities will bring the effective total of the various NSF programs shown in this activity to $58.9 million.

Within the STIA activity, the $36.8 million will provide:

- Support for visiting scientists, workshops, seminars and conferences necessary to establish and maintain the participation of U.S. scientists and engineers in bilateral international scientific activities.
- Funds for 3-4 new Industry/University Cooperative Research Centers and 6-10 new planning grants for additional centers.
- A 16.7 percent increase in the Industry/University Cooperative Research Project program.
- Support to obtain international S&T resource data and other indicators in industrial countries, and increased support for data on women and minorities in science and engineering.
- Increased support for new research efforts in risk analysis, an area of growing importance in the regulatory policy area.

The additional $22.1 million to be provided within the Foundation's discipline oriented research programs will provide:

- Approximately $6.0 million for first year support of up to 200 Presidential Young Investigators Research Awards. An equivalent amount in matching funds will be required from private sources, particularly from industry.
- $5.9 million for support of research conducted under bilateral agreements and an additional $2.0 million to initiate a new U.S./India Joint Program.
- Up to $3.0 million for a new program to encourage independent faculty research in the Nation's predominantly undergraduate colleges and to improve generally the research environment in the institutions that provide baccalaureate degrees for so many of our scientists and engineers.
- $2.5 million for the Experimental Program to Stimulate Competitive Research, to fulfill with existing commitments. Except for a few possible closeout costs, this will complete the planned support for this program.

PROGRAM DEVELOPMENT AND MANAGEMENT (PD&M)

The Program Development and Management activity provides resources for the effective management of NSF.

The FY 1984 Budget Request for the PD&M activity is $66.0 million, which represents an increase of $0.7 million or 1.1 percent from the FY 1983 Current Plan of $65.3 million. The number of Full-Time Equivalent staff for the Foundation is reduced from 1,218 in FY 1983 to 1,194 in the FY 1984 Budget Request, a decrease of 2.0 percent.

Within the amount requested for FY 1984:

- o Personnel compensation and benefits are funded at $48.2 million, a decrease of $0.6 million or 1.2 percent below the FY 1983 amount.
- o Travel for staff, proposal reviewers, panelists and advisers remains level with the FY 1983 Current Plan.
- o The overall increase in the other categories is $1.3 million or 9.6 percent. This requirement restores the central support administrative services to only a 4.9 percent increase over the FY 1982 actual usage. The majority of items in these categories such as rent, telephone, telegraph, postage and audit services is not discretionary and is subject to uncontrollable increases.
- o There is no increase over FY 1983 in the amount requested for data processing equipment. This funding will maintain the long range plan for adding work stations and communication equipment to the Foundation's data processing and management information system.
- o Grants, Subsidies & Contributions will be maintained at the FY 1983 level.

SCIENCE AND ENGINEERING EDUCATION (SEE)

The FY 1984 Budget Request for the Science and Engineering Education activity is $39.0 million. The request includes $19.0 million for the NSF Graduate Research Fellowships subactivity and $20.0 million for the Precollege Teacher Improvement in Science and Mathematics subactivity.

The FY 1983 Current Plan for the SEE activity totals $30.0 million. The Graduate Research Fellowships subactivity will be funded at $15.0 million and the new programs under the Precollege Teacher Improvement in Science and Mathematics subactivity will be funded at $15.0 million. In FY 1983 NSF will introduce two Presidential initiatives in science education addressing the critical problem of secondary school instruction in science and mathematics:

- o Presidential Awards for Teaching Excellence in Science and Mathematics to recognize outstanding secondary school teachers of science and mathematics who can serve as models for their colleagues and provide increased status and rewards for demonstrated professionalism; and

- Presidential Secondary School Science and Mathematics Teaching Improvement program which will support workshops and training activities to improve the knowledge of science and mathematics for teachers of these subjects in grades 6 through 12.

The request for FY 1984 reflects an increase of $9.0 million over the FY 1983 Current Plan. Four million of the increase will be used to raise the stipend and cost-of-education allowance of approximately 1,390 graduate fellows. The stipend will be increased $1,200 from $6,900 to $8,100 while the cost-of-education allowance will be increased by $900 from $4,000 to $4,900.

The remaining $5.0 million will be used to expand the Presidential Secondary School Science and Mathematics Teaching Improvement program.

Increasing the Vitality of the Research Base

The vitality of the Nation's scientific research base depends critically on three interdependent factors: (i) the strength and quality of the human resource pool from which our current and future scientists, engineers and technicians are drawn; (ii) the quality of the educational system that produces this human resource pool; and (iii) the quality and availability of advanced research instrumentation necessary to undertake cutting edge scientific research. Each of these critical factors is addressed in the FY 1984 Budget Request in a variety of ways. Each is important to the achievement of our national economic objectives.

STRENGTHENING THE HUMAN RESOURCE POOL

Today the Nation is experiencing shortages of qualified teaching personnel in its colleges and universities in areas such as computer science, certain fields of engineering and earth sciences. The shortages result from rapid growth in selected high technology industries and the consequent increased demand for professionals in these and other specialties. In many instances, high salaries and opportunities to work with state of the art research instrumentation have placed academic institutions at a competitive disadvantage in the market.

The problem extends to students as well, as more and more are attracted to industry, which is willing to hire holders of bachelor's and master's degrees at salaries that make the economic rewards for advanced degree work extremely unattractive. There is also evidence that secondary school teachers of mathematics and related disciplines are being caught up by the growing demand and are leaving the field of education for more economically attractive opportunities.

As a result of these trends, the present pool of academic scientific and engineering talent required to produce basic scientific research and technical innovations as well as to educate the professionals and technicians on whom our economic growth depends is losing some of its most outstanding human potential. This problem is exacerbated by the relative lack of participation by women and ethnic minorities in careers in science and technology.

The FY 1984 Budget Request proposes new Presidential Young Investigators Awards to be given to young faculty at research universities who are within 7 years of their doctorate in a field of science or engineering where the attractiveness of academic careers needs enhancing. No more than 200 such awards will be given each year, for up to 5 years of research support, at an average of $30,000 per year per award. Funds from the private sector will be required to match the Foundation's contribution, ensuring improved ties between universities and industry in these important areas of science and engineering.

The Foundation's Graduate Research Fellowship Program will support approximately 1,390 graduate fellows in FY 1984 at an increased stipend of $8,100 per year plus a cost-of-education allowance of $4,900. Included in this total are 45 new Minority Graduate Fellowships. In addition, as the

table below shows, there will be an estimated increase of 8.4 percent in the number of graduate students supported on research projects and an estimated increase of 16.2 percent in the amount of support provided to them between FY 1983 and FY 1984. These research assistants, who are selected on the basis of quality and congruence of interest between faculty and students, play a key role in the successful conduct of the work which NSF funds. In addition, their learning experience as research apprentices helps prepare them for future careers in science or engineering.

SUPPORT OF GRADUATE STUDENTS ON RESEARCH PROJECTS

(Numbers and Obligations in Millions of Dollars)

	Number Supported				*Amount of Support*			
	Actual FY 1982	*Estimate FY 1983*	*Estimate FY 1984*	*% Diff. FY 84/83*	*Actual FY 1982*	*Estimate FY 1983*	*Estimate FY 1984*	*%Diff. FY 84/83*
Research & Related Activities:								
Mathematical and Physical Sciences	3,930	4,009	4,332	8.1%	$30.7	$33.6	$40.3	19.9%
Engineering	1,755	1,835	2,030	10.6	16.9	18.7	21.6	15.5
Biological, Behavioral and Social Sciences	1,687	1,730	1,891	9.3	10.5	11.3	12.9	14.2
Astronomical, Atmospheric, Earth & Ocean Sciences	1,549	1,638	1,823	11.3	12.0	13.3	15.3	15.0
U.S. Antarctic Program	92	97	108	11.3	.6	.6	.7	16.7
Scientific, Technological, & International Affairs	288	288	216	-25.0	1.3	2.1	1.8	-14.3
Subtotal, Res. & Related	9,301	9,597	10,400	8.4%	$72.0	$79.6	$92.6	16.3%
Special Foreign Currency	40	34	28	-17.6%	.2	.2	.1	-50.0%
TOTAL, NSF	**9,341**	**9,631**	**10,428**	**8.3%**	**$72.2**	**$79.8**	**$92.7**	**16.2%**

Support of the Minority Research Initiation (MRI) program is anticipated at $2.0 million in the FY 1984 Budget Request, maintaining it level with the FY 1983 Current Plan. Similarly, the program for Visiting Professorships for Women (VPW) will remain level with the FY 1983 Current Plan at a total of $1.5 million. The MRI program, which funds research by full-time minority faculty members at any institution who have had no previous Federal research support, has made about 35 awards at an average amount of $80,000 during the past two fiscal years. The VPW program, which began in FY 1982 to encourage careers for women in science and engineering and to give greater visibility to women researchers, provides a limited number of awards to women who hold doctorates or have equivalent experience in science and engineering and have demonstrated independent research capability. Women working in industrial, academic or public sector positions are eligible to apply.

The Foundation is committed to expanding opportunities for women and ethnic minority group members to participate fully in scientific and engineering research careers. There are challenges for the other institutions of science and engineering as well: scientific and professional societies; universities and colleges; private industry; and other Federal agencies. Each

needs to examine its own policies and programs to insure that the research enterprise responds to opportunities to expand and utilize the full potential of the scientific and technical labor force.

IMPROVING THE EDUCATIONAL BASE

The educational base for producing the Nation's future research scientists, engineers, and technicians consists of a continuum extending from primary and secondary schools through undergraduate colleges and universities to graduate and professional schools. As students move through these institutions, they make a series of choices leading to adult careers in science and engineering. These choices are influenced very much by the quality of the faculty and teaching which students encounter and, at later stages, by the opportunities they have to gain first hand knowledge of the research process.

The Foundation's major responsibilities lie in graduate education and training in research, which it supports through fellowships, stipends in research awards for graduate research assistants, and by monitoring and evaluating personnel trends and the status of science and engineering education. In primary and secondary education NSF can play an important role by helping to identify critical needs and by encouraging scientific and professional societies, academic institutions, state and local governments, private industry, and other Federal agencies to meet these challenges.

In FY 1983 two new Presidential initiatives were instituted, aimed at improving the knowledge and science and mathematics instructional skills for teachers of mathematics and science in grades 6 through 12. There is national recognition of the fact that the quality of teaching in these subjects has deteriorated in the last decade or so at the same time that graduation requirements and admission requirements to college have been reduced.

The Presidential Awards for Teaching Excellence in Science and Mathematics program identifies outstanding secondary school teachers of the subjects who can serve as models for their colleagues. The FY 1984 Budget Request maintains this program at the FY 1983 level, providing support for 100 Awards -- half in science, half in mathematics -- to teachers who will be selected nationally from each state and other jurisdictions such as Puerto Rico and the District of Columbia.

Support for the Presidential Secondary School Science and Mathematics Teaching Improvement program is increased in FY 1984 over the FY 1983 Current Plan. This program, initiated in FY 1983, supports workshops and training activities to improve the subject matter knowledge of science and mathematics for teachers in grades 6 through 12. It is estimated that by FY 1984, it will have reached some 11,500 teachers.

In April, 1982, the National Science Board established a Commission to examine the current state of education at the precollege level in mathematics, science and technology. It was charged to develop an agenda which defined the roles of all sectors of society involved with or having an interest in the Nation's public school system. Twenty persons of various expertise, who are highly respected in their fields, were asked to serve as Commissioners. They

represent the business and industrial communities, higher education, precollege education and local governing groups.

Another critical part of the link in the educational base which provides the Nation's future engineers and scientists is the small, predominantly undergraduate college. A significant proportion of those awarded the PhD in science, mathematics and engineering receive their baccalaureate at these institutions. For the period between 1967 - 1976, for example, more than 9,500 PhD recipients in chemistry had their baccalaureates from 198 predominantly undergraduate colleges. In FY 1982, 20 percent of the NSF Graduate Research Fellowships went to graduates of such colleges. Since these colleges serve as such an important pipeline for entry into the system of graduate education, and finally, into the overall scientific and technical enterprise of the country, it is important that faculty in these institutions receive support and encouragement for maintaining their research capability.

In prior years, the NSF operated two research activities especially oriented towards this audience: the Two-and Four-Year College Research Instrumentation Program, aimed at institutional physical resource improvement, and a small college faculty research opportunities effort that provided a way for motivated faculty at these small institutions to participate in research under the aegis of NSF investigation at larger institutions.

The FY 1984 Budget Request builds on and refocuses these previous efforts by proposing a new program, Undergraduate College Research Support, to be supported at the level of $3.0 million. It will be coordinated through the STIA Activity, but managed and budgeted for in all of the Foundation's major research activities to insure that the work which it supports is adequately coordinated with other NSF-supported research and facilities at the Nation's leading research institutions.

The program will emphasize independent research by faculty at these predominantly undergraduate colleges, using the physical resources of major university, industrial or government research centers, and will encourage the inclusion of advanced undergraduate students as part of the research team. Funds for essential permanent equipment will also be provided. This program will thus help improve the quality of the research environment at small institutions which serve as major sources of future scientists, engineers and technicians.

Finally, the FY 1984 Budget Request will continue support of the Research Improvement in Minority Institutions (RIMI) program that was established in FY 1982 in response to Executive Order 12320, to help predominantly minority colleges and universities with graduate science or engineering programs to improve their research capabilities. Four awards were made in FY 1982 and an additional eight awards are anticipated in FY 1983. Support in FY 1984 will be level with that provided in the FY 1983 Current Plan.

One project funded in FY 1982 at Howard University strengthens the semiconductor research program at the only historically minority institution in the U.S. that offers a doctoral degree in electrical engineering. Another project at Jackson State University uses its chemical physics research laboratory to study the structure and dynamics of molecular ions and other unique small molecular systems. Researchers at the University of Puerto Rico

are using a high resolution scanning electron microscope with an energy dispersive spectrometer to study polycrystalline semiconductors, selective surfaces and other materials. A project at Atlanta University supports studies which form the initial core of an institutional research program in applied mathematics and computational physics. Support of similar projects at predominantly minority institutions will be provided in FY 1984.

RESEARCH INSTRUMENTATION

Sophisticated instrumentation, measuring devices, and data processing and manipulating equipment are of central importance to the conduct of cutting-edge research in virtually every field of science and engineering today. These devices open opportunities to make new or more accurate measurements of physical or biological phenomena, enable the investigator to obtain data from previously inaccessible material or environments, and improve the ability of the researcher to manipulate and interpret the data obtained. Thus an investment in research instrumentation is an investment that increases both the quality of the science that can be pursued and the productivity of the investigator.

The growing importance of instrumentation has contributed significantly to the increased cost of research in the past decade. Though the average size of awards in chemistry, for example, has increased over recent years, this increase is insufficient to accommodate the substantially increased costs of instrumentation in this industrially significant field.

In contrast to chemistry, which is instrumentation intensive, research excellence in mathematics depends on opportunities for interaction among researchers. Over the past few years, the Foundation has emphasized the support of research in mathematics and established two mathematical science research institutes aimed at addressing different aspects of this problem. The institute at the University of California at Berkeley enhances opportunities for interaction among mathematicians, the second at the University of Minnesota facilitates interactions among mathematicians and other scientists. This facilitates the work of mathematicians holding promise for contributing to advances in other fields of science and engineering. Since these institutes were established during a time of decreasing support for mathematics in general, they were funded at the expense of individual research projects.

As a final example, the rate of instrumentation acquisition at both university and National astronomical observatories is far below the optimum desirable to take advantage of many exciting scientific opportunities in astronomy. In addition to detectors and receivers, small and medium scale computers are of particular importance. The former are used in telescope pointing, data acquisition and initial processing while medium scale computers are important for processing data from both radio and optical instruments in order to form astronomical images and maps. Lack of funds to acquire such computers has significantly decreased both the speed and type of research that U.S. astronomers are able to undertake. As these examples illustrate, each field of science has been affected differently by increased cost of research support.

The FY 1984 Budget Request addresses the problem of increased need for instrumentation by placing a high priority on research instrumentation in most of the Foundation's programs. As the following table shows, it is estimated that support of research instrumentation for NSF as a whole will increase by 100 percent between FY 1982 and FY 1984, and by 60.5 percent between FY 1983 and FY 1984. The change is most marked for engineering, though all of the Foundation's major research activities estimate sizable increases in their support of instrumentation.

R&D EQUIPMENT AND INSTRUMENTATION
(Obligations in Millions of Dollars)

	Actual FY 1982	*Estimate FY 1983*	*Estimate FY 1984*	*Increase (Percent)* FY 84/82	FY 84/83
Mathematical and Physical Sciences	$41.7	$56.4	$86.3	107.0%	53.0%
Engineering	6.4	8.7	18.2	184.4	109.2
Biological, Behavioral, and Social Sciences	14.3	16.2	24.6	72.0	51.9
Astronomical, Atmospheric, Earth and Ocean Sciences	19.6	22.1	36.7	87.2	66.1
U.S. Antarctic Program	6.0	6.6	12.1	101.7	83.3
Scientific, Technological and International Affairs	2.1	2.3	2.3	9.5	.0
TOTAL, NSF	$90.1	$112.3	$180.2	100.0%	60.5%

Each of the Foundation's programs will be addressing the support of research instrumentation in ways most appropriate to it. This permits maximum flexibility in attending to the equipment needs in each discipline, as to size, cost, and method of provision. The computer program, for example, has established an instrumentation element that will provide support for the purchase of mini-computers by individual investigators. The Biological Instrumentation program element in the BBS activity will provide equipment grants for multi-user, more expensive equipment such as electron microscopes and nuclear magnetic resonance spectrometers. Primary emphasis will be on such instruments as spectrophotometers and centrifuges which cost from $15,000 to $50,000 and are supported through project grants.

The Engineering activity will provide support for instrumentation through project grants and special equipment awards. The astronomy subactivity plans to support new, smaller class, sub-millimeter and optical telescopes in the $1-2 million range at universities or one of the National astronomical centers.

There are opportunities here for other Federal agencies to respond to instrumentation needs. The Foundation, with the support of the President's Science Adviser, has organized and chaired the Interagency Working Group on University Research Instrumentation with representatives from the Department of Defense, the Department of Health and Human Services, the Department of Energy, the Department of Agriculture, and National Aeronautics and Space Administration.

These agencies, which, with NSF, provide over 95 percent of Federal support of university research, are acquiring further data on the state of university research instrumentation, taking new initiatives within their

research budgets to place greater emphasis on instrumentation, focusing small business funds on research instrumentation innovators and making Federal laboratories more readily available to university researchers.

Universities, in turn, have accepted responsibility for improving their management of instrumentation and are about to embark on a major educational effort to encourage new financing arrangements, equipment sharing, more responsive university regulatory policies and adequate maintenance. An important revision in OMB Circular A-21 has accelerated these efforts.

Industry, particularly manufacturers of equipment, have made some increased contributions of instruments under an incentive included in the Economic Recovery Tax Act of 1981. In a few cases, manufacturers have also agreed to provide deep discounts for equipment purchased by National Science Foundation grantees.

Some Significant Recent Accomplishments of NSF-Supported Projects

The new knowledge resulting from successful Foundation-funded projects provides the primary base for assessing the effectiveness of Foundation programs and their management. During 1982, the results of work supported under earlier NSF awards were reported at numerous scientific meetings and published in a wide variety of scientific journals and books. The following items are examples of noteworthy scientific accomplishments of broad interest.

NOBEL PRIZE FOR PHASE TRANSITIONS RESEARCH

The 1982 Nobel Prize in Physics was awarded to Kenneth Wilson of Cornell University for his work on phase transitions and critical phenomena. Wilson used a powerful technique which has become known as the renormalization group to analyze the behavior of matter at "critical points," where phase transitions occur. The work of Wilson and his colleagues has led to a quantitative understanding of liquid-gas and other phase transitions. At least as important, their work delineated the key concepts involved, and explained the relation between different kinds of phase transitions. Renormalization group concepts are currently being used by Wilson and others to study modern theories of elementary particles.

NOVEL MATHEMATICAL AND COMPUTATIONAL TECHNIQUES

The study of two dimensional random processes has application in such diverse fields as meteorology, geodesy, topographical mapping, seismic exploration, rolled steel production and electroencephalography. A novel and highly efficient mathematical and computational technique to extract useful information from noisy data obtained at different times and at different locations in space has been devised by Alan Willsky and Bernard Levy at MIT. The approach is based on using the underlying model of the desired information (such as types of defects in a product) together with computer processing

techniques to obtain accurate and fast results. The significance of the method is not only in its standard applications to low dose medical tomography and oil exploration, but also in unusual applications, such as nondestructive testing of manufactured products (e.g., rolled steel) via attenuation tomography. These applications have an economic impact on improved quality and productivity in manufacturing and other fields.

LOCATION IN THE BRAIN OF MEMORY FOR MOTOR BEHAVIOR

The search for the location in the brain where learned information is stored has been long and elusive. Richard Thompson and his colleagues at Stanford University believe they have localized a brain region involved in the storage of a specific memory. The investigators taught an animal to change the movement of its eye and eye-covering membrane in response to an audible sound. When a small portion of the brain (i.e., a specific nucleus of the cerebellum) was removed from these animals, the learned behavior disappeared even though the normal movement of the eye and eye-covering membrane was not impaired. The cerebellum has been known for a long time to be involved in control of motor behavior, but was not suspected to be specifically involved in memory. Subsequent studies have shown a similar effect with a conditioned leg flexion response to a tone. These are the first demonstrations that a specific kind of learned information may be stored at a discrete site in the brain. These discoveries provide the basis for further investigations to localize other sites of memory storage and to understand the basis of learning pathologies.

NORTH AMERICAN CONTINENTAL ACCRETION

Recent NSF-funded projects, including those led by Rob Coe at the University of California-Santa Cruz and David Stone of the University of Alaska, have shown through geologic and paleomagnetic study that enormous areas in Alaska and the northwestern United States were originally formed far from the present North American continent. Results show that these state-sized blocks were transported thousands of kilometers by plate-tectonic forces and were added to the original continental edge at a much later time. Such a situation is actually to be expected in areas where seafloor is being consumed under the edge of a continent, as was the case all along the Pacific margin when the so-called exotic terranes were being emplaced (about 200 million years ago). However, the recognition of these areas as far-traveled blocks is a very recent development.

The present Appalachian Mountains were the site of much earlier ocean floor subduction and the presence of accreted terranes is suspected for the eastern continental margin as well. For example, very recent work in Newfoundland and Maine by Dennis Kent of Lamont-Doherty Geological Observatory indicates that parts of these areas actually formed south and east of Florida, and were subsequently transported to their present position.

Each block is expected to carry its own geology and mineral resources due to its independent origin. Therefore, the identification and separate study of each is of considerable importance not only to the understanding of how continental margins develop, but also to the mineral potential of these regions.

DYNAMICS OF SOLIDIFICATION

An interdisciplinary group of scientists (J. Langer, a theoretical physicist now at the Institute for Theoretical Physics at the University of California at Santa Barbara, W. Mullins and R. Sekerka, theoretical metallurgists, S. Kou, a metallurgical engineer, and G. Fix, an applied mathematician) at Carnegie-Mellon University's Center for the Joining of Materials has made an important advance in understanding the dynamics of solidification. This research was initiated because standard approaches were unable to treat situations, like welding, where supercooling of the liquid and superheating of the solid could occur. This difficulty was overcome by developing a new concept, called the phase field, which gives a mathematical description of the structure of both phases and of the interface between them. The phase field concept has allowed the derivation of mathematical equations which accurately describe the kinetics of crystal growth and which can be solved numerically. These workers have applied their theory to welding problems, and have found remarkable agreement between their predictions and the measured dimensions of the molten zone, which exists during an arc-welding operation. Further, their approach is thought to be adaptable to a variety of materials and welding conditions. Thus, it may now be possible to calculate accurately relevant parameters for realistic welding situations. The striking possibilities of using this approach in robotic controlled welding processes, where accurate and reliable process control is essential, make these fundamental studies particularly exciting.

PLANT DISEASE GENES

Plant disease is a major source of crop plant loss. One of the worst losses occurred in the early 1970's when a single disease resulted in a 70 percent loss in the corn crop in the U.S. When specific pathogens attack, plants respond with a predictable set of symptoms. The symptomology permits identification of viral, fungal or bacterial diseases because each type of disease results in leaf lesions of a typical size, shape and distribution pattern on the leaf.

Virginia Walbot of Stanford University and M.G. Neuffer and David Hoisington of the University of Missouri have described corn variants that display leaf lesions typical of a fungal disease in the absence of the fungus. This suggests that the plant contains genes (called *Les* genes) that control the expression of lesion formation.

Walbot and her associates have found that environmental stress such as extremely high or low temperature can induce lesion formation in some plants. These scientists postulate that *Les* genes are activated to produce lesions that mimic the disease. They have been able to breed the variant *Les* genes into various corn types and have found that those types known to be very susceptible to disease also show an enhanced response to temperature or other stress activation of *Les* genes. This would be expected if the response to the activation of the *Les* genes is the same as the response to the invasion of the disease organism. Genetic experiments have shown that *Les* type genes are unusually common; in fact, there may be hundreds of the genes in corn. The

ability to produce lesions in the absence of a disease organism provides the opportunity to examine the mechanism of lesion formation. Walbot and her collaborators have shown that it is under genetic control. Particularly interesting is the possibility that expression of Les genes may actually be controlled to make a plant resistant to infection by pathogens.

MICROBURSTS AND AIRCRAFT HAZARD

T. Fujita, University of Chicago, has joined John McCarthy, National Center for Atmospheric Research, to direct the Joint Airport Weather Study (JAWS) to investigate very intense, short-lived downdrafts. Some of these downdrafts occur very close to the ground and lead to an outward burst of air when the downward rushing air spreads horizontally. This phenomenon has been called a microburst. An aircraft crossing a microburst will encounter first a strong head wind and then a strong tail wind after it passes the burst's center, an extremely hazardous situation. The microburst has been implicated as a major factor in a number of aircraft accidents and near accidents during takeoff and landing. The field experiment phase of JAWS was conducted in the Denver-Stapleton airport area from May 15 to August 15, 1982. It was successful in accumulating a large amount of data from over 50 wind shear occurrences that were observed and measured. Analysis, synthesis and interpretation of these extensive data sets will be performed over the next several years in order to improve our understanding and detection of microbursts.

ULTRASOUND USED TO INCREASE CATALYTIC REACTION RATE

A team of chemists has developed a way to initiate catalytic reactions by using high intensity sound, a method that could increase the rates of some chemical reactions a million fold. Ultrasound has been used for a variety of chemical processes, but never before to induce a catalytic reaction in solution. Kenneth S. Suslick of the University of Illinois at Urbana-Champaign and his co-workers have discovered that high intensity ultrasound can induce unusual chemical reactions and can produce catalysis of reactions which do not occur in the absence of sound.

Catalysts are agents that speed up chemical reactions which are normally too slow to be practical. The catalyst must often be activated itself in solution to function, usually by heating the solution or by shining intense light into the solution. Some reactions will not tolerate high temperatures, however, because other undesired products would then be formed; using light to create such catalysts is limited to those compounds which can be conveniently stimulated with light. In contrast to activation by heating, the use of ultrasound to initiate catalysis does not require a significant increase in the temperature of the reaction mixture and can be easily done on a large scale.

CONVERSION OF METHANE FOR INDUSTRIAL USE

Methane, the colorless, odorless gas that is the major constituent of natural gas is burned conveniently as a fuel, but the selective combination of this raw material with oxygen to form useful products has been an elusive goal of researchers. Jack H. Lundsford of Texas A&M University has successfully converted methane to methanol, a substance used by the chemical industry for a wide variety of products which could eventually include gasoline. The key to this conversion process was the use of nitrous oxide (commonly known as laughing gas) as the source of oxygen for the chemical reaction. Lundsford's results demonstrate how important technological developments can result from fundamental research in heterogenous catalysis. The development of a simple reactor to convert methane to a more easily transportable fuel or chemical could have significant economic impact on the natural gas industry.

SUBMARINE PERMAFROST UNDER THE ALASKAN ARCTIC OCEAN

Research by scientists from the University of Alaska has shown that there are extensive areas of permafrost in the sediments of the continental shelf off the North Slope of Alaska. This frozen ground beneath the Arctic Ocean is apparently a relic of permafrost formed before the sea rose to its present level during the last several thousand years. It is preserved because the salt water of the Arctic Ocean is colder than the freezing point of the fresh-water permafrost. The identification of the distribution, depth, and instability of the permafrost by the University of Alaska will help the petroleum industry to adapt well-placement and drilling practices to the permafrost areas.

CAPTURING HUMAN EXPERTISE IN COMPUTER SYSTEMS

Computers have been traditionally designed and used for scientific computations that involve complex but well defined processes. Recent computer research has led to new approaches and uses of computer systems known as "expert systems." Typically, an expert system will follow problem-solving procedures used by human experts to assist non-experts in solving complex problems in specific knowledge-based areas. To be useful, an expert system must have a knowledge base and the ability to manipulate that knowledge base. Considerable progress has been made in advancing the state-of-the-art of expert systems research on a number of fronts. At Stanford University, for example, a team of researchers led by Edward Feigenbaum has developed expert systems that can aid in medical diagnosis, formulate rules of mass spectrometry, and analyze data in protein crystallography. Other possible applications and future opportunities for expert systems research include such diverse fields as education, law, engineering design, building and construction, as well as energy exploration and development.

A NEW TYPE OF VARIABLE STAR

Most stellar brightnesses that are observed to vary with time do so as a consequence of changes in the star's radius. It was not until 9 years ago that variable stars were discovered among white dwarfs, those relics which mark the end of stellar evolution for all stars no more massive than our sun. These stars have collapsed as the result of internal exhaustion of their hydrogen fuel through its conversion to heavy elements. Though only some white dwarfs are observed to pulsate, all those in a particular temperature (color) range do. This implies that all white dwarfs pass through this phase at some time during their nearly-expired lives. Despite the exhaustion of their internal hydrogen, most white dwarfs still possess a residue of the element in their surface layers. However, the surfaces of some white dwarfs contain only helium. On the basis of their similar structure, an astronomer at the University of Texas predicted that helium-rich white dwarfs of a certain temperature range should also pulsate. When he and two collaborators turned a telescope at the McDonald Observatory toward a star with the proper characteristics, they found that the object did indeed pulsate. It is the first type of variable star whose existence was predicted by theory prior to its discovery. The finding is also important in that it provides direct confirmation of white dwarf pulsation theory.

WAR AGAINST TERMITES--NEW PESTICIDE DEVELOPED

Termites annually cost U.S. property owners an estimated $750 million. A chemist at the State University of New York at Stony Brook, Glenn D. Prestwich, has developed a new pesticide which uses methods that the insects themselves employ to kill their enemies. The substance works because it affects the termites' fat metabolism; that is, it represses the biochemical reactions that provide energy to the body cells. Using a technique called vacuum impregnation, the lethal chemical is introduced to tiny blocks of wood from the sweet gum, ash or aspen trees that produce wood that is just right--neither too hard nor too soft. As an added lure, Prestwich has the blocks of wood pre-rotted by a fungus, resulting in a delicacy termites find irresistible. The blocks are attached to wooden spikes and the deadly bait is driven into the ground to await the visit of hungry termites. Once the termites have dined on the lethal chemical, they return to their colonies to live about three more days--the time it takes to digest and activate poisoned food. During this time they transfer the poison to their fellow nest mates, killing as many as 60,000 of them at a time.

The new insecticide has many advantages over previously used poisons in getting rid of termites. For example, it can be delivered so that it doesn't affect all insects -- only termites -- and it remains effective long enough to wipe out entire colonies. The new insecticide has another big advantage over most other poisons--it leaves no harmful residue and so it doesn't pollute the environment.

BUDGET SUMMARY OF OBLIGATIONS BY ACTIVITY AND SUBACTIVITY SHOWING DOLLAR AND PERCENTAGE CHANGES, FY 1984/FY 1983

(Millions of Dollars)

Activity & Subactivity	Actual FY 1982	Current Plan FY 1983	Estimate FY 1984	Difference FY 1984/FY 1983 Amount	Difference FY 1984/FY 1983 Percent
RESEARCH & RELATED ACTIVITIES APPROPRIATION					
Mathematical and Physical Sciences					
Mathematical Sciences	$30.5	$34.7	$42.2	$7.5	21.5
Computer Research	25.7	29.1	34.7	5.6	19.1
Physics	75.3	88.9	107.6	18.7	21.1
Chemistry	61.4	66.2	80.2	14.0	21.2
Materials Research	79.9	80.8	99.6	18.8	23.2
Subtotal, MPS	272.8	299.7	364.3	64.6	25.5
Engineering					
Electrical, Computer & Systems Engineering	25.8	29.3	36.7	7.4	25.3
Chemical & Process Engineering	20.4	22.3	27.1	4.8	21.5
Civil & Environmental Engineering	29.9	30.0	34.4	4.4	14.7
Mechanical Sciences & Engineering	17.2	19.2	24.8	5.6	29.2
Subtotal, Engineering	93.3	100.8	123.0	22.2	22.0
Biological, Behavioral, and Social Sciences					
Physiology, Cellular & Molecular Biology	80.1	85.5	102.7	17.2	20.1
Biotic Systems and Resources	42.0	45.7	53.6	7.9	17.1
Behavioral and Neural Sciences	31.7	33.8	37.9	4.1	12.2
Social & Economic Sciences	17.6	19.8	23.3	3.5	17.7
Information Sciences and Technology	5.2	5.4	6.1	0.7	13.0
Subtotal, BBS	176.6	190.2	223.6	33.4	17.5
Astronomical, Atmospheric, Earth and Ocean Sciences					
Astronomical Sciences	59.1	63.0	79.3	16.3	25.9
Atmospheric Sciences	70.4	75.0	90.6	15.6	20.7
Earth Sciences	29.5	34.1	42.1	8.0	23.5
Ocean Sciences	75.0	81.2	89.1	7.9	9.8
Ocean Drilling Programs	20.0	16.5	26.3	9.8	59.4
Arctic Research Program	5.9	6.3	7.5	1.2	19.0
Subtotal, AAEO	259.9	276.1	334.9	58.8	21.3
U.S. Antarctic Program					
U.S. Antarctic Research Program	8.5	9.0	10.0	1.0	11.1
Operations Support	60.0	74.2	92.1	17.9	24.1
Subtotal, USAP	68.5	83.2	102.1	18.9	22.7
Scientific, Technological, and International Affairs					
Industrial Science and Technology Innovation	12.9	14.5	16.5	2.0	13.8
International Cooperative Scientific Activities	11.6	9.9	5.0	-4.9	-49.5
Policy Research & Analysis	3.9	4.1	4.6	0.5	12.2
Science Resources Studies	3.1	3.5	4.2	0.7	20.0
Research Initiation Improvement	8.8	12.2	6.5	-5.7	-46.6
Subtotal, STIA	40.3	44.2	36.8	-7.4	-16.7
Program Development and Management	63.2	65.3	66.0	0.7	1.1
Undistributed	—0—	4.5	—0—	-4.5	-100.0
Total, Research and Related Activities	974.6	1,064.0	1,250.7	186.7	17.5

BUDGET SUMMARY OF OBLIGATIONS BY ACTIVITY AND SUBACTIVITY SHOWING DOLLAR AND PERCENTAGE CHANGES, FY 1984/FY 1983

(Millions of Dollars)

Activity & Subactivity	Actual FY 1982	Current Plan FY 1983	Estimate FY 1984	Difference FY 1984/FY 1983 Amount	Difference FY 1984/FY 1983 Percent
SCIENCE AND ENGINEERING EDUCATION ACTIVITIES APPROPRIATION					
Graduate Research Fellowships	[15.0]	15.0	19.0	4.0	26.7
Pre-College Teacher in Science and Mathematics	—0—	15.0	20.0	5.0	33.3
Scientific Personnel Improvement	16.7	—0—	—0—	—0—	—0—
Science Education Development and Research	2.7	—0—	—0—	—0—	—0—
Science Education Communication	1.2	—0—	—0—	—0—	—0—
NSB Commission on Pre-College Education in Mathematics, Science and Technology	.3	—0—	—0—	—0—	—0—
Total, Science and Engineering Activities Appropriation	20.9	30.0	39.0	9.0	30.0
SPECIAL FOREIGN CURRENCY APPROPRIATION					
Research and Related Activities	3.6	3.1	2.6	-0.5	-16.1
Total, Special Foreign Currency Appropriation	3.6	3.1	2.6	-0.5	-16.1
Total, NSF	**969.1**	**1,097.2**	**1,292.3**	**195.1**	**17.8**

BUDGET SUMMARY OF NEW OBLIGATIONAL AUTHORITY BY ACTIVITY AND SUBACTIVITY SHOWING DOLLAR AND PERCENTAGE CHANGES, FY 1984/FY 1983

(Millions of Dollars)

Activity & Subactivity	Actual FY 1982	New Obligational Authority FY 1983[1]	Estimate FY 1984	Difference FY 1984/FY 1983 Amount	Difference FY 1984/FY 1983 Percent
RESEARCH & RELATED ACTIVITIES APPROPRIATION:					
Mathematical and Physical Sciences:					
Mathematical Sciences	$30.5	$34.0	$42.2	$ 8.2	24.1
Computer Research	25.7	29.1	34.7	5.6	19.2
Physics	75.3	89.1	107.6	18.5	20.8
Chemistry	61.4	66.4	80.2	13.8	20.7
Materials Research	79.9	81.0	99.6	18.6	23.0
Subtotal, MPS	272.8	299.6	364.3	64.7	21.6
Engineering:					
Electrical, Computer & Systems Engineering	25.8	29.3	36.7	7.4	25.3
Chemical & Process Engineering	20.4	22.3	27.1	4.8	21.5
Civil & Environmental Engineering	29.9	30.0	34.4	4.4	14.7
Mechanical Sciences & Engineering	17.2	19.2	24.8	5.6	29.1
Subtotal, ENG	93.3	100.8	123.0	22.2	22.0
Biological, Behavioral, and Social Sciences:					
Physiology, Cellular & Molecular Biology	80.1	85.7	102.7	17.0	19.8
Environmental Biology	42.0	45.7	53.6	7.9	17.3
Behavioral and Neural Sciences	31.7	33.8	37.9	4.1	12.1
Social & Economic Science	17.6	19.7	23.3	3.6	18.2
Information Science	5.2	5.4	6.1	.7	13.0
Subtotal, BBS	176.6	190.3	223.6	33.3	17.5
Astronomical, Atmospheric, Earth and Ocean Sciences:					
Astronomical Sciences	59.1	63.2	79.3	16.1	25.5
Atmospheric Sciences	70.4	76.1	90.6	14.5	19.0
Earth Sciences	29.5	33.5	42.1	8.6	25.7
Ocean Sciences	75.0	80.4	89.1	8.7	10.8
Ocean Drilling Programs	20.0	16.5	26.3	9.8	59.4
Arctic Research	5.9	6.3	7.5	1.2	19.0
Subtotal, AAEO	259.9	276.0	334.9	58.9	21.3
U.S. Antarctic Program:					
U.S. Antarctic Research Program	8.5	9.0	10.0	1.0	11.1
Operations Support	60.0	73.4	92.1	18.7	25.5
Subtotal, USAP	68.5	82.4	102.1	19.7	23.9

BUDGET SUMMARY OF NEW OBLIGATIONAL AUTHORITY BY ACTIVITY AND SUBACTIVITY SHOWING DOLLAR AND PERCENTAGE CHANGES, FY 1984/FY 1983 - CONTINUED

(Millions of Dollars)

Activity & Subactivity	Actual FY 1982	New Obligational Authority FY 1983[1]	Estimate FY 1984	Difference FY 1984/FY 1983 Amount	Difference FY 1984/FY 1983 Percent
Scientific, Technological, and International Affairs:					
Industrial Science and Technology Innovation	12.9	14.5	16.5	2.0	13.8
International Cooperative Scientific Activities	11.6	9.9	5.0	-4.9	-49.5
Policy Research & Analysis	3.9	4.1	4.6	.5	12.2
Science Resources Studies	3.1	3.5	4.2	.7	20.0
Research Initiation and Improvement	8.8	12.0	6.5	-5.5	-45.8
Subtotal, STIA	40.3	44.0	36.8	-7.2	-16.4
Program Development and Management	63.2	62.4	66.0	3.6	5.8
Undistributed	—0—	4.5	—0—	-4.5	-100.0
Subtotal, Research and Related Activities Appropriation	974.6	1,060.0	1,250.7	190.7	18.0
SCIENCE AND ENGINEERING EDUCATION ACTIVITIES APPROPRIATION					
Graduate Research Fellowships	(15.0)	15.0	19.0	4.0	26.7
Precollege Teacher Improvement in Science & Mathematics	.0	15.0	20.0	5.0	33.3
Science Personnel Improvement	16.7	—0—	—0—	—0—	—0—
Science Education Development and Research	2.7	—0—	—0—	—0—	—0—
Science Education Communication	1.2	—0—	—0—	—0—	—0—
NSB Commission on Pre-College Education in Mathematics, Science and Technology	.3	—0—	—0—	—0—	—0—
Subtotal, Science and Engineering Education Activities Appropriation	20.9	30.0	39.0	9.0	30.0
SPECIAL FOREIGN CURRENCY APPROPRIATION:					
Research and Related Activities	3.6	2.2	2.6	.4	18.2
TOTAL, NSF	**999.1**	**1,092.2**	**1,292.3**	**200.1**	**18.3**

[1]The FY 1983 New Obligational Authority is the distribution of the FY 1983 appropriation and excludes the application of FY 1982 unobligated carryover balances and subsequent adjustments necessary to partially absorb the additional costs of the October 1982 pay increase, Medicare payments, and costs resulting from the lifting of the statutory limitation on salaries.

SUMMARY BUDGET INFORMATION BY ACTIVITY AND SUBACTIVITY FY 1982-FY 1984

The following tables summarize the National Science Foundation's FY 1982 through FY 1984 budgets by appropriation title.

Activity	Actual FY 1982	Request FY 1983	Current Plan FY 1983	Estimate FY 1984	Difference FY 1984/83
A. Summary of Funding Level by Activity					
Research and Related Activities					
Mathematical and Physical Sciences	$272,842,614	$296,700,000	$299,716,437	$364,300,000	$64,583,563
Engineering	93,285,529	99,700,000	100,800,000	123,000,000	22,200,000
Biological, Behavioral and Social Sciences	176,597,165	186,700,000	190,242,890	223,600,000	33,357,110
Astronomical, Atmospheric, Earth and Ocean Sciences	259,852,856	273,700,000	276,109,368	334,900,000	58,790,632
U.S. Antarctic Program	68,504,786	86,400,000	83,200,000	102,100,000	18,900,000
Scientific, Technological, and International Affairs	40,324,426	44,000,000	44,166,230	36,800,000	-7,366,230
Minority Institutions Science Improvement Program	—0—	3,287,000	—0—	—0—	—0—
Program Development and Management	63,182,341	63,081,000	65,312,404	66,000,000	687,596
Undistributed	—0—	—0—	4,500,000	—0—	-4,500,000
Subtotal, Research and Related Activities	974,589,717	1,055,568,000	1,064,047,329	1,250,700,000	186,652,671
Unobligated Balances and Other Adjustments	-2,994,717	—0—	-2,347,329	—0—	2,347,329
Research and Related Activities Appropriation	971,595,000	1,055,568,000	1,061,700,000	1,250,700,000	189,000,000
Science and Engineering Education Activities					
Graduate Research Fellowships	[14,999,999]	[15,000,000]	15,000,000	19,000,000	4,000,000
Pre-College Teacher Improvement in Science and Mathematics	—0—	—0—	15,000,000	20,000,000	5,000,000
Scientific Personnel Improvement	16,745,101	15,000,000	—0—	—0—	—0—
Science Education Development and Research	2,672,106	—0—	—0—	—0—	—0—
Science Education Communication	1,186,357	—0—	—0—	—0—	—0—
NSB Commission on Pre-College Education	293,672	—0—	—0—	—0—	—0—
Subtotal, Science and Engineering Education Activities	20,897,236	15,000,000	30,000,000	39,000,000	9,000,000
Unobligated Balances and Other Adjustments	2,764	—0—	—0—	—0—	—0—
Science and Engineering Education Activities Appropriation	20,900,000	15,000,000	30,000,000	39,000,000	9,000,000
Special Foreign Currency Program	3,654,702	2,200,000	3,118,067	2,600,000	-518,067
Unobligated Balances and Other Adjustments	-574,702	—0—	-918,067	—0—	918,067
Special Foreign Currency Appropriation	3,080,000	2,200,000	2,200,000	2,600,000	400,000
TOTAL, NSF APPROPRIATIONS	995,575,000	1,072,768,000	1,093,900,000	1,292,300,000	198,400,000

Level of Funding by Program—Continued

Activity	Actual FY 1982	Request FY 1983	Current Plan FY 1983	Estimate FY 1984	Difference FY 1984/83
B. Mathematical and Physical Sciences					
I. Mathematical Sciences					
Classical Analysis	$3,165,330	$3,340,000	$3,320,000	$4,100,000	$780,000
Modern Analysis	3,257,852	3,470,000	3,430,000	4,150,000	720,000
Geometric Analysis	2,926,673	3,220,000	3,120,000	3,850,000	730,000
Topology and Foundations	3,979,911	4,300,000	4,190,000	5,150,000	960,000
Algebra and Number Theory	5,047,834	5,360,000	5,330,000	6,600,000	1,270,000
Applied Mathematics	3,767,803	4,100,000	4,050,000	5,300,000	1,250,000
Statistics and Probability	3,431,813	3,510,000	3,560,000	4,700,000	1,140,000
Special Projects	4,911,312	6,600,000	7,706,437	8,325,000	618,563
Subtotal	$30,488,528	$33,900,000	$34,706,437	$42,175,000	$7,468,563
II. Computer Research					
Theoretical Computer Science	$3,224,555	$3,250,000	$3,200,000	$3,700,000	$500,000
Software Systems Science	3,149,751	3,400,000	3,100,000	3,700,000	600,000
Software Engineering	3,132,891	3,200,000	3,000,000	3,500,000	500,000
Intelligent Systems	3,347,627	3,200,000	3,000,000	3,500,000	500,000
Computer Systems Design	3,077,885	3,400,000	3,100,000	3,600,000	500,000
Coordinated Experimental Research	8,552,738	11,250,000	11,175,000	13,725,000	2,550,000
Special Projects	1,259,645	1,600,000	1,245,000	1,450,000	205,000
Computer Research Equipment	—0—	—0—	1,300,000	1,500,000	200,000
Subtotal	$25,745,092	$29,300,000	$29,120,000	$34,675,000	$5,555,000
III. Physics					
Elementary Particle Physics	$26,223,386	$28,400,000	$29,400,000	$36,650,000	$7,250,000
Intermediate Energy Nuclear Physics	12,569,448	14,200,000	14,100,000	17,400,000	3,300,000
Nuclear Physics	12,970,299	20,300,000	20,100,000	23,000,000	2,900,000
Atomic, Molecular, and Plasma Physics	9,611,596	10,300,000	10,200,000	12,500,000	2,300,000
Theoretical Physics	9,452,371	10,400,000	10,300,000	12,100,000	1,800,000
Gravitational Physics	4,496,000	4,900,000	4,800,000	6,000,000	1,200,000
Subtotal	$75,323,100	$88,500,000	$88,900,000	$107,650,000	$18,750,000
IV. Chemistry					
Structural Chemistry and Thermodynamics	$12,247,000	$13,300,000	$13,190,000	$15,410,000	$2,220,000
Chemical Physics	10,021,513	11,000,000	10,890,000	12,800,000	1,910,000
Chemical Dynamics	12,155,800	13,000,000	13,140,000	15,640,000	2,500,000
Chemical Analysis	6,850,118	7,500,000	7,330,000	8,410,000	1,080,000
Synthetic Inorganic and Organometallic Chemistry	6,673,800	7,800,000	7,250,000	8,420,000	1,170,000
Synthetic Organic and Natural Products Chemistry	7,544,916	7,900,000	8,100,000	9,720,000	1,620,000
Chemical Instrumentation	5,862,549	5,800,000	6,290,000	9,850,000	3,560,000
Subtotal	$61,355,696	$66,100,000	$66,190,000	$80,250,000	$14,060,000
V. Materials Research					
Solid State Physics	$8,543,500	$10,250,000	$8,950,000	$10,800,000	$1,850,000
Solid State Chemistry	5,973,700	6,850,000	6,500,000	8,000,000	1,500,000
Low Temperature Physics	6,294,099	5,750,000	6,200,000	7,400,000	1,200,000
Condensed Matter Theory	5,992,700	6,550,000	6,500,000	8,000,000	1,500,000
Metallurgy	8,251,699	8,700,000	7,900,000	9,500,000	1,600,000
Ceramics	4,561,700	4,900,000	4,450,000	5,400,000	950,000
Polymers	5,280,200	6,000,000	5,400,000	6,600,000	1,200,000
Instrumentation for Materials Research	—0—	—0—	4,000,000	7,800,000	3,800,000
Materials Research Laboratories	22,505,100	24,200,000	23,450,000	27,750,000	4,300,000
National Magnet Laboratory	4,507,600	4,700,000	4,650,000	5,100,000	450,000
Synchrotron Radiation	7,519,900	2,400,000	2,250,000	2,600,000	350,000
Small Angle Scattering	500,000	600,000	550,000	600,000	50,000
Subtotal	$79,930,198	$80,900,000	$80,800,000	$99,550,000	$18,750,000

Level of Funding by Program—Continued

Activity	Actual FY 1982	Request FY 1983	Current Plan FY 1983	Estimate FY 1984	Difference FY 1984/83
TOTAL, MATHEMATICAL AND PHYSICAL SCIENCES	$272,842,814	$298,700,000	$299,716,437	$364,300,000	$64,583,563
C. Engineering					
I. Electrical, Computer, and Systems Engineering					
Automation, Bioengineering, and Sensing Systems	$4,758,147	$5,140,000	$4,939,000	$6,350,000	$1,411,000
Electrical and Optical Communications	4,478,200	5,300,000	5,141,000	6,350,000	1,209,000
Computer Engineering	2,607,296	2,590,000	2,500,000	3,700,000	1,200,000
Quantum Electronics, Waves and Beams	4,095,336	4,670,000	4,534,000	5,400,000	866,000
Solid State and Microstructures Engineering	4,793,000	5,730,000	5,556,000	7,200,000	1,644,000
Systems Theory and Operations Research	4,404,963	4,770,000	4,630,000	5,400,000	770,000
Science and Technology to Aid the Handicapped	846,823	—0—	2,000,000	2,300,000	300,000
Subtotal	$25,783,767	$28,200,000	$29,300,000	$36,700,000	$7,400,000
II. Chemical and Process Engineering					
Kinetics, Catalysis and Reaction Engineering	$3,298,722	$3,650,000	$3,650,000	$4,490,000	$840,000
Chemical and Biochemical Processes	4,148,412	4,550,000	4,550,000	5,800,000	1,250,000
Engineering Energetics	3,278,213	3,330,000	3,330,000	3,800,000	470,000
Thermodynamics and Transport Phenomena	3,400,943	3,500,000	3,500,000	4,240,000	740,000
Particulate and Multiphase Processes	3,096,600	3,370,000	3,370,000	3,950,000	580,000
Separation Processes	1,421,600	1,800,000	1,800,000	2,330,000	530,000
Minerals and Primary Materials Processing	1,734,400	2,100,000	2,100,000	2,490,000	390,000
Subtotal	$20,374,890	$22,300,000	$22,300,000	$27,100,000	$4,800,000
III. Civil and Environmental Engineering					
Geotechnical Engineering	$2,750,079	$3,300,000	$3,300,000	$4,000,000	$700,000
Structural Mechanics	2,734,886	2,900,000	2,900,000	3,700,000	800,000
Hydraulics, Hydrology, and Water Resources Engineering	3,491,530	3,700,000	3,700,000	4,400,000	700,000
Environmental and Water Quality Engineering	2,710,089	2,800,000	2,800,000	3,300,000	500,000
Earthquake Hazard Mitigation:					
Siting	7,851,960	7,750,000	7,750,000	8,100,000	350,000
Design	8,462,629	7,400,000	7,400,000	8,600,000	1,200,000
Societal Response	1,931,999	2,150,000	2,150,000	2,300,000	150,000
Subtotal	$18,266,588	$17,300,000	$17,300,000	$19,000,000	$1,700,00 0
Subtotal	$29,953,172	$30,000,000	$30,000,000	$34,400,000	$4,400,000
IV. Mechanical Engineering and Applied Mechanics					
Fluid Mechanics	$4,087,318	$4,400,000	$4,400,000	$5,400,000	$1,000,000
Heat Transfer	3,775,711	4,200,000	4,200,000	5,700,000	1,500,000
Solid Mechanics	3,619,805	3,850,000	3,850,000	4,700,000	850,000
Mechanical Systems	2,429,000	3,250,000	3,250,000	4,450,000	1,200,000
Production Research	3,261,846	3,500,000	3,500,000	4,550,000	1,050,000
Subtotal	$17,173,680	$19,200,000	$19,200,000	$24,800,000	$5,600,000
TOTAL, ENGINEERING	$93,285,529	$99,700,000	$100,800,000	$123,000,000	$22,200,000

Level of Funding by Program—Continued

Activity	Actual FY 1982	Request FY 1983	Current Plan FY 1983	Estimate FY 1984	Difference FY 1984/83
D. Biological, Behavioral, and Social Sciences					
I. Physiology, Cellular, and Molecular Biology					
Molecular and Genetic Biosciences					
Biochemistry	$10,672,315	$11,100,000	$11,100,000	$12,924,000	$1,824,000
Biophysics	10,066,838	10,600,000	10,700,000	12,433,000	1,733,000
Genetic Biology	11,502,279	12,200,000	12,296,000	15,076,200	2,780,200
Metabolic Biology	10,749,861	11,500,000	11,425,000	14,133,000	2,708,000
Alternative Biological Resources	1,753,081	1,900,000	1,900,000	2,350,000	450,000
Subtotal	$44,764,374	$47,300,000	$47,421,000	$56,916,200	$9,495,200
Cellular and Physiological Biosciences					
Cell Biology	$7,816,546	$8,400,000	$8,500,000	$10,279,000	$1,779,000
Cellular Physiology	5,876,854	6,300,000	6,300,000	7,444,000	1,144,000
Developmental Biology	9,264,530	10,000,000	10,080,800	12,675,800	2,595,000
Regulatory Biology	7,638,492	8,000,000	8,000,000	8,900,000	900,000
Subtotal	$30,616,422	$32,700,000	$32,880,800	$39,298,800	$6,418,000
Biological Instrumentation	4,731,797	5,200,000	5,200,000	6,485,000	1,285,000
Subtotal	$80,112,593	$85,200,000	$85,501,800	$102,700,000	$17,198,200
II. Biotic Systems and Resources					
Ecological Science					
Ecology	$6,239,000	$7,400,000	$6,770,000	$8,060,000	$1,290,000
Ecosystem Studies	15,027,875	15,600,000	15,520,000	16,860,000	1,340,000
Subtotal	$21,266,875	$23,000,000	$22,290,000	$24,920,000	$2,630,000
Systematic and Population Biology					
Systematic Biology	$7,990,674	$9,000,000	$9,010,000	$11,040,000	$2,030,000
Population Biology and Physiological Ecology	6,082,774	6,700,000	6,630,000	8,640,000	2,010,000
Biological Research Resources	6,649,651	6,300,000	7,644,290	8,800,000	1,155,710
Subtotal	$20,723,299	$22,000,000	$23,484,290	$28,680,000	$5,195,710
Subtotal	$41,990,174	$45,000,000	$45,774,290	$53,600,000	$7,825,710
III. Behavioral and Neural Sciences					
Neuroscience					
Neurobiology	$10,105,188	$10,800,000	$11,180,900	$13,000,000	$1,819,100
Sensory Physiology and Perception	6,667,600	7,400,000	6,500,000	7,600,000	1,100,000
Psychobiology	3,581,168	3,600,000	3,700,000	3,800,000	100,000
Subtotal	$20,353,956	$21,800,000	$21,380,900	$24,400,000	$3,019,100
Cognitive Science					
Memory and Cognitive Processes	$2,293,054	$2,300,000	$2,300,000	$2,600,000	$300,000
Social and Developmental Psychology	1,499,264	1,800,000	2,100,000	2,200,000	100,000
Linguistics	2,081,204	2,200,000	2,200,000	2,400,000	200,000
Subtotal	5,873,522	6,100,000	6,600,000	7,200,000	600,000
Anthropology	5,508,248	5,600,000	5,800,000	6,300,000	500,000
Subtotal	$31,735,726	$33,500,000	$33,780,900	$37,900,000	$4,119,100

Level of Funding by Program—Continued

Activity	Actual FY 1982	Request FY 1983	Current Plan FY 1983	Estimate FY 1984	Difference FY 1984/83
IV. Social and Economic					
Economics and Geography					
Economics	$6,333,285	$6,380,000	$7,100,000	$9,100,000	$2,000,000
Geography	706,896	700,000	800,000	1,000,000	200,000
Subtotal	7,040,181	7,080,000	7,900,000	10,100,000	2,200,000
Social Measurement and Analysis					
Sociology	2,200,000	2,200,000	2,400,000	2,800,000	400,000
Measurement Methods and Data Resources	2,884,000	2,068,000	3,300,000	3,500,000	200,000
History and Philosophy of Science	900,000	900,000	1,050,000	1,200,000	150,000
Subtotal	5,984,000	6,068,000	6,750,000	7,500,000	750,000
Political and Policy Sciences					
Political Science	2,100,000	2,100,000	2,330,000	2,600,000	270,000
Law and Social Sciences	1,100,000	1,100,000	1,200,000	1,250,000	50,000
Regulation and Policy Analysis	900,000	800,000	850,000	900,000	50,000
Decision and Management Science	436,432	652,000	758,900	950,000	191,100
Subtotal	$4,536,432	$4,652,000	$5,138,900	$5,700,000	$561,100
Subtotal	$17,560,613	$17,800,000	$19,788,900	$23,300,000	$3,511,100
V. Information Sciences					
Information Science	$4,028,060	$4,000,000	$4,000,000	$4,000,000	—0—
Information Technology	369,999	400,000	597,000	1,000,000	$403,000
Information Impact	800,000	800,000	800,000	1,100,000	300,000
Subtotal	$5,198,059	$5,200,000	$5,397,000	$6,100,000	$703,000
TOTAL, BIOLOGICAL, BEHAVIORAL AND SOCIAL SCIENCES	$176,597,166	$186,700,000	$190,242,890	$223,600,000	$33,357,110
E. Astronomical, Atmospheric, Earth, and Ocean Sciences					
I. Astronomical Sciences					
Astronomy Project Support					
Solar System Astronomy	$1,425,000	$1,510,000	$1,510,000	$2,200,000	$690,000
Stars and Stellar Evolution	4,219,900	4,485,000	4,485,000	5,460,000	975,000
Stellar Systems and Motion	1,325,000	1,400,000	1,400,000	1,590,000	190,000
Galactic and Extragalactic Astronomy	6,591,146	7,015,000	7,015,000	8,840,000	1,825,000
Astronomical Instrumentation and Development	5,999,642	6,500,000	6,690,000	9,800,000	3,110,000
Electro-Magnetic Spectrum Management	100,000	100,000	100,000	110,000	10,000
Subtotal	$19,660,688	$21,010,000	$21,200,000	$28,000,000	$6,800,000
National Astronomy and Ionosphere Center					
Scientific Research Support	$5,645,000	$6,005,000	$5,315,000	$6,515,000	$1,200,000
Construction	—0—	—0—	—C—	—0—	—0—
Less NASA Support	-325,000	-315,000	-315,000	-315,000	—0—
Subtotal	$5,320,000	$5,690,000	$5,000,000	$6,200,000	$1,200,000
Kitt Peak National and Cerro-Tololo Inter-American Observatories					
Scientific Research Support	$16,948,700	$18,155,000	$18,298,000	$21,565,000	$3,267,000
Management Fee	328,000	335,000	335,000	335,000	—0—
Subtotal	$17,276,700	$18,490,000	$18,633,000	$21,900,000	$3,267,000

Level of Funding by Program—Continued

Activity	Actual FY 1982	Request FY 1983	Current Plan FY 1983	Estimate FY 1984	Difference FY 1984/83
National Radio Astronomy Observatory					
Scientific Research Support	$14,545,000	$15,555,000	$15,735,000	$20,270,000	$4,535,000
Management Fee	295,000	315,000	315,000	330,000	15,000
Subtotal	$14,840,000	$15,870,000	$16,050,000	$20,600,000	$4,550,000
Sacramento Peak Observatory					
Scientific Research Support	$2,318,000	$2,480,000	$2,440,000	$2,965,000	$525,000
Management Fee	49,000	50,000	50,000	50,000	—0—
Less DOD Support	−367,000	−390,000	−390,000	−415,000	−25,000
Subtotal	$2,000,000	$2,140,000	$2,100,000	$2,600,000	$500,000
Subtotal	$59,097,388	$63,200,000	$62,983,000	$79,300,000	$16,317,000
II. Atmospheric Sciences					
Atmospheric Project Support					
Aeronomy	$6,912,114	$7,000,000	$8,600,000	$9,800,000	$1,200,000
Atmospheric Chemistry	5,130,078	5,700,000	5,700,000	6,900,000	1,200,000
Climate Dynamics	5,864,495	6,550,000	6,100,000	7,400,000	1,300,000
Experimental Meteorology	2,984,871	3,500,000	3,900,000	5,400,000	1,500,000
Global Atmospheric Research Program (GARP)	5,685,384	5,750,000	5,050,000	4,800,000	−250,000
Meteorology	5,493,579	7,300,000	6,900,000	8,500,000	1,600,000
Solar Terrestrial Research	5,463,951	6,000,000	6,000,000	7,200,000	1,200,000
Subtotal	$38,534,472	$41,800,000	$42,250,000	$50,000,000	$7,750,000
National Center for Atmospheric Research					
Atmospheric Analysis and Prediction	$2,621,000	$2,906,000	$2,675,000	$3,547,000	$872,000
Atmospheric Chemistry and Aeronomy	2,043,000	2,220,000	2,105,000	2,731,000	626,000
Convective Storms	1,861,000	1,997,000	2,063,000	2,340,000	277,000
Advanced Study Program	1,041,000	1,108,000	1,100,000	1,366,000	266,000
High Altitude Observation	2,748,000	3,011,000	2,992,000	3,622,000	630,000
Atmospheric Technology	7,412,000	6,012,000	5,974,000	7,511,000	1,537,000
Scientific Computing	5,294,051	7,544,000	7,338,000	10,377,000	3,039,000
Administration and Support Services	3,506,000	4,006,000	4,521,000	4,842,000	321,000
Physical Plant Operation and Maintenance	2,978,000	3,396,000	3,032,000	3,364,000	332,000
Contractor Fee	800,000	800,000	800,000	900,000	100,000
Subtotal	$30,304,051	$33,000,000	$32,600,000	$40,600,000	$7,800,000
National Scientific Balloon Facility	$1,500,000	—0—	—0—	—0—	—0—
Subtotal	$70,338,523	$74,800,000	$75,050,000	$90,600,000	$15,550,000
III. Earth Sciences					
Stratigraphy and Paleontology	$3,960,857	$4,450,000	$4,400,000	$4,800,000	$400,000
Environmental Geosciences	1,595,352	2,600,000	2,600,000	2,900,000	300,000
Crustal Structure and Tectonics	3,996,596	5,000,000	5,000,000	5,900,000	900,000
Seismology and Deep Earth Structure	5,198,200	6,100,000	5,800,000	6,400,000	600,000
Experimental and Theoretical Geophysics	3,698,700	3,600,000	3,900,000	5,700,000	1,800,000
Petrogenesis and Mineral Resources	3,036,986	3,950,000	4,000,000	5,200,000	1,200,000
Mantle Geochemistry	2,234,173	3,200,000	3,100,000	4,000,000	900,000
Experimental and Theoretical Geochemistry	5,766,511	5,500,000	5,300,000	7,200,000	1,900,000
Subtotal	$29,489,377	$34,400,000	$34,100,000	$42,100,000	$8,000,000

Level of Funding by Program—Continued

Activity	Actual FY 1982	Request FY 1983	Current Plan FY 1983	Estimate FY 1984	Difference FY 1984/83
IV. Ocean Sciences					
Ocean Science Research					
Physical Oceanography	$13,750,000	$14,300,000	$14,200,000	$15,600,000	$1,400,000
Marine Chemistry	10,350,000	11,100,000	11,100,000	12,300,000	1,200,000
Submarine Geology and Geophysics	12,018,642	12,800,000	12,700,000	14,900,000	2,200,000
Biological Oceanography	10,788,000	11,800,000	11,700,000	12,900,000	1,200,000
Subtotal	$46,906,642	$50,000,000	$49,700,000	$55,700,000	$6,000,000
Oceanographic Facilities and Support					
Operations	$23,662,000	$25,000,000	$24,700,000	$25,900,000	$1,200,000
Ocean Technology Program	4,461,428	6,000,000	6,776,368	7,500,000	723,632
Subtotal	$28,123,428	$31,000,000	$31,476,368	$33,400,000	$1,923,632
Subtotal	$75,030,070	$81,000,000	$81,176,368	$89,100,000	$7,923,632
V. Ocean Drilling Programs					
Ocean Drilling Programs	$29,757,657	$24,000,000	$24,605,689	$29,500,000	$4,894,311
Less Foreign Funding	−8,557,657	−10,000,000	−8,000,000	−1,200,000	6,800,000
Less Other U.S. Agency Funds	−1,200,000	—0—	−105,689	−2,000,000	−1,894,311
Subtotal	$20,000,000	$14,000,000	$16,500,000	$26,300,000	$9,800,000
VI. Arctic Research Program					
Atmospheric Sciences	$799,056	$900,000	$900,000	$1,000,000	$100,000
Biological Sciences	1,722,347	1,800,000	1,800,000	2,000,000	200,000
Earth Sciences	999,992	1,100,000	1,100,000	1,100,000	—0—
Glaciology	1,181,151	1,125,000	1,125,000	2,000,000	875,000
Oceanography	1,038,952	1,200,000	1,200,000	1,225,000	25,000
Information and Advisory Services	156,000	175,000	175,000	175,000	—0—
Subtotal	$5,897,498	$6,300,000	$6,300,000	$7,500,000	$1,200,000
TOTAL, ASTRONOMICAL, ATMOSPHERIC, EARTH AND OCEAN SCIENCES	$259,852,856	$273,700,000	$276,109,368	$334,900,000	$58,790,632
F. U.S. Antarctic Program					
I. U.S. Antarctic Research Program					
Atmospheric Sciences	$1,945,961	$1,900,000	$1,900,000	$2,100,000	$200,000
Biological Sciences	2,188,223	2,200,000	2,200,000	2,400,000	200,000
Earth Sciences	1,348,000	1,500,000	1,500,000	1,700,000	200,000
Glaciology	1,025,669	1,400,000	1,400,000	1,600,000	200,000
Oceanography	1,303,169	1,350,000	1,350,000	1,550,000	200,000
Information and Advisory Services	686,662	650,000	650,000	650,000	—0—
Subtotal	$8,497,684	$9,000,000	$9,000,000	$10,000,000	$1,000,000
II. Operations and Support Program					
Direct Science Support	$10,100,000	$10,100,000	$10,100,000	$12,100,000	$2,000,000
Base Level Support	42,807,102	54,700,000	55,500,000	60,400,000	4,900,000
Major Construction and Procurement	7,100,000	12,600,000	8,600,000	19,600,000	11,000,000
Subtotal	$60,007,102	$77,400,000	$74,200,000	$92,100,000	$17,900,000
TOTAL, U.S. ANTARCTIC PROGRAM	$68,504,786	$86,400,000	$83,200,000	$102,100,000	$18,900,000

Level of Funding by Program—Continued

Activity	Actual FY 1982	Request FY 1983	Current Plan FY 1983	Estimate FY 1984	Difference FY 1984/83
G. Scientific, Technological, and International Affairs					
I. Industrial Science and Technological Innovation					
Industry/University Cooperative Research Projects	$5,500,000	$6,000,000	$6,000,000	$7,000,000	$1,000,000
Small Business Innovation Programs	5,087,293	5,500,000	5,500,000	5,500,000	—0—
Industry/University Cooperative Research Centers	1,499,979	2,000,000	2,000,000	3,000,000	1,000,000
Productivity Improvement Research	812,135	1,000,000	1,000,000	1,000,000	—0—
Subtotal	$12,899,407	$14,500,000	$14,500,000	$16,500,000	$2,000,000
II. International Cooperative Scientific Activities					
International Cooperative Science	$8,354,101	$9,100,000	$8,800,000	$3,900,000	$–4,900,000
International Science Organizations and Resources	3,228,650	800,000	1,100,000	1,100,000	—0—
Subtotal	$11,582,751	$9,900,000	$9,900,000	$5,000,000	$–4,900,000
III. Policy Research and Analysis					
Socioeconomic Effects of Science and Technology	$1,653,753	$1,750,000	$1,750,000	$1,750,000	—0—
Technology Assessment and Risk Analysis	1,295,654	1,350,000	1,350,000	1,850,000	$500,000
Advanced Technologies and Resources Policy	950,588	1,000,000	1,000,000	1,000,000	—0—
Subtotal	$3,899,995	$4,100,000	$4,100,000	$4,600,000	$500,000
IV. Science Resources Studies					
Science and Technology Personnel	$1,886,112	$1,600,000	$1,600,000	$2,100,000	$500,000
Funding of Science and Technology	842,000	1,200,000	1,200,000	1,300,000	100,000
Modeling of Special Science and Technology Indicators	410,000	700,000	700,000	800,000	100,000
Subtotal	$3,138,112	$3,500,000	$3,500,000	$4,200,000	$700,000
V. Research Initiation and Improvement					
Presidential Young Investigators Research Awards	—0—	—0—	—0—	($8,000,000)	—0—
Undergraduate College Research Support	—0—	—0—	—0—	(3,000,000)	—0—
Two-and-Four-Year College Research Instrumentation	($1,966,461)	—0—	($2,000,000)	—0—	—0—
Visiting Professorships for Women	948,257	$1,000,000	1,500,000	1,000,000	$–500,000
Minority Research Initiation	1,430,111	2,500,000	2,000,000	2,000,000	—0—
Research Improvement in Minority Institutions	907,826	2,000,000	2,000,000	2,000,000	—0—
Experimental Program to Stimulate Competitive Research	3,000,000	2,500,000	2,500,000	(2,500,000)	–2,500,000
Intergovernmental Science and Technology	500,000	500,000	500,000	500,000	—0—
Ethics and Values in Science and Technology	700,000	1,000,000	1,000,000	1,000,000	—0—
NSF Planning and Evaluation	1,317,967	2,500,000	2,666,230	(2,500,000)	–2,666,230
Alan T. Waterman Award	(150,000)	(150,000)	(150,000)	(150,000)	—0—
Subtotal	$8,804,161	$12,000,000	$12,166,230	$6,500,000	$–5,666,230

Level of Funding by Program—Continued

Activity	Actual FY 1982	Request FY 1983	Current Plan FY 1983	Estimate FY 1984	Difference FY 1984/83
TOTAL, SCIENTIFIC, TECHNOLOGICAL AND INTERNATIONAL AFFAIRS	$40,324,426	$44,000,000	$44,166,230	$36,800,000	$–7,366,230
H. Minority Institutions Science Improvement					
Minority Institutions Science Improvement Program	—0—	$3,287,000	—0—	—0—	—0—
I. Program Development and Management	63,182,341	63,081,000	65,312,404	66,000,000	687,596
Full-time Equivalent Employment—Permanent	1,091	1,070	1,074	1,053	–21
Full-time Equivalent Employment—Other	151	166	144	141	– 3
Full-time Equivalent Employment—Total	1,242	1,236	1,218	1,194	–24
Subtotal, Research and Related Activities	$974,589,717	$1,055,568,000	$1,064,047,329	$1,250,700,000	$186,652,671
J. Undistributed					
Undistributed	—0—	—0—	4,500,000	—0—	–4,500,000
Unobligated Balances, and Other Adjustments	$2,994,717	—0—	$–2,347,329	—0—	$2,347,329
Research and Related Activities Appropriation	$971,595,000	$1,055,568,000	$1,061,700,000	$1,250,000,000	$189,000,000
K. Science and Engineering Education					
I. Graduate Research Fellowships	($14,999,999)	($15,000,000)	$15,000,000	$19,000,000	$4,000,000
II. Precollege Teacher Improvement in Science and Mathematics	—0—	—0—	15,000,000	20,000,000	5,000,000
III. Scientific Personnel Improvement	16,745,101	15,000,000	—0—	—0—	—0—
IV. Science Education Development and Research	2,672,106	—0—	—0—	—0—	—0—
V. Science Education Communication	1,186,357	—0—	—0—	—0—	—0—
VI. NSB Commission on Pre-College Education	293,672	—0—	—0—	—0—	—0—
TOTAL, SCIENCE AND ENGINEERING EDUCATION	$20,897,236	$15,000,000	$30,000,000	$39,000,000	$9,000,000
Unobligated Balances and Other Adjustments	$2,764	—0—	—0—	—0—	—0—
Science and Engineering Education Activities Appropriation	$20,900,000	$15,000,000	$30,000,000	$39,000,000	$9,000,000
L. Special Foreign Currency Program					
Research and Related Activites	$3,654,702	$2,200,000	$3,118,067	$2,600,000	$–518,067
Unobligated Balances and Other Adjustments	$–574,702	—0—	$–918,067	—0—	$918,067
Special Foreign Currency Program	$3,080,000	$2,200,000	$2,200,000	$2,600,000	$400,000
TOTAL NSF APPROPRIATIONS	$995,575,000	$1,072,768,000	$1,093,900,000	$1,292,300,000	198,400,000

Figures in parentheses are on-add for comparison purposes only.

NATIONAL SCIENCE FOUNDATION

RESEARCH AND RELATED ACTIVITIES APPROPRIATION

ANALYSIS OF CHANGES IN OBLIGATED LEVELS
FY 1982—FY 1984

	Obligations
FY 1982 Obligated Level	$974,589,717
FY 1983 Increases:	
Mathematical and Physical Sciences	26,873,823
Engineering	7,514,471
Biological, Behavioral and Social Sciences	13,645,725
Astronomical, Atmospheric, Earth and Ocean Sciences	16,256,512
U S. Antarctic Program	14,695,214
Scientific, Technological and International Affairs	3,841,804
Program Development and Management	2,130,063
Undistributed	4,500,000
Subtotal	89,457,612
FY 1983 Obligated Level	1,064,047,329
FY 1984:	
Increases:	
Mathematical and Physical Sciences	64,583,563
Engineering	22,200,000
Biological, Behavioral and Social Sciences	33,357,110
Astronomical, Atmospheric, Earth and Ocean Sciences	58,790,632
U.S. Antarctic Program	18,900,000
Program Development and Management	687,596
Subtotal	198,518,901
Decreases:	
Scientific, Technological and International Affairs	-7,366,230
Undistributed	-4,500,000
Subtotal	-11,866,230
FY 1984 Obligated Level	1,250,700,000

NATIONAL SCIENCE FOUNDATION

SCIENCE AND ENGINEERING EDUCATION ACTIVITIES APPROPRIATION

ANALYSIS OF CHANGES IN OBLIGATED LEVELS

FY 1982—FY 1984

	Obligations
FY 1982 Obligated Level	$20,897,236
FY 1983:	
Increases:	
Graduate Research Fellowships	15,000,000
Pre-College Teacher Improvement in Science and Mathematics	15,000,000
Subtotal	30,000,000
Decreases:	
Scientific Personnel Improvement	-16,745,101
Science Education Development and Research	-2,672,106
Science Education Communication	-1,186,357
NSB Commission on Pre-College Education in Mathematics, Science and Technology	-293,672
Subtotal	-20,897,236
FY 1983 Obligated Level	30,000,000
FY 1984 Increases:	
Graduate Research Fellowships	4,000,000
Pre-College Teacher Improvement in Science and Mathematics	5,000,000
Subtotal	9,000,000
FY 1984 Obligated Level	**39,000,000**

NATIONAL SCIENCE FOUNDATION

SPECIAL FOREIGN CURRENCY APPROPRIATION

ANALYSIS OF CHANGES IN OBLIGATED LEVELS
FY 1982—FY 1984

	Obligations
FY 1982 Obligated Level	$3,654,702
FY 1983:	
Decrease:	
Research and Related Activities	-536,635
FY 1983 Obligated Level	3,118,067
FY 1984:	
Decrease:	
Research and Related Activities	-518,067
FY 1982 Obligated Level	**$2,600,000**

NATIONAL SCIENCE FOUNDATION

PERCENTAGE DISTRIBUTION OF TOTAL OBLIGATIONS

FY 1982—FY 1984

	Actual FY 1982	*Request FY 1983*	*Current Plan FY 1983*	*Estimate FY 1984*
Research and Related Activities				
Mathematical and Physical Sciences	27.3	27.8	27.3	28.2
Engineering	9.3	9.3	9.2	9.5
Biological, Behavioral and Social Sciences	17.7	17.4	17.4	17.3
Astronomical, Atmospheric, Earth and Ocean Sciences	26.0	25.5	25.2	25.9
U.S. Antarctic Program	6.9	8.1	7.8	7.9
Scientific, Technological and International Affairs	4.0	4.1	4.0	2.8
Minority Institutions Science Improvement Program	—0—	.3	—0—	—0—
Program Development and Management	5.3	5.9	5.9	5.1
Undistributed	—0—	—0—	.4	—0—
Subtotal	97.5	98.4	97.0	96.8
Science and Engineering Activities				
Graduate Research Fellowships	—0—	—0—	1.4	1.5
Pre-College Teacher Improvement in Science and Mathematics	—0—	—0—	1.4	1.5
Science Personnel Improvement	1.7	1.4	—0—	—0—
Science Education Development and Research	.3	—0—	—0—	—0—
Science Education Communication	.1	—0—	—0—	—0—
NSB Commission on Pre-College Education in Mathematics, Science and Technology	(1)	—0—	—0—	—0—
Subtotal	2.1	1.4	2.8	3.0
Special Foreign Currency	.4	.2	.2	.2
Total, NSF	100.0	100.0	100.0	100.0

[1] Less than .1 percent.

NATIONAL SCIENCE FOUNDATION
SUMMARY OF OBLIGATIONS BY MAJOR OBJECT CLASSIFICATION

Object	Actual FY 1982	Budget Request FY 1983	Current Plan FY 1983	Estimate FY 1984	Difference FY 1984/83
Research and Related Activities					
Personnel Compensation	$42,396,222	$41,112,000	$44,390,000	$43,830,000	$-560,000
Personnel Benefits	3,810,163	3,496,000	4,395,404	4,340,000	-55,404
Travel and Transportation of Persons	2,859,643	3,020,000	3,020,000	3,020,000	—0—
Transportation of Things	231,211	250,000	235,000	300,000	65,000
Rents and Communications	7,845,901	8,060,000	7,630,000	8,250,000	620,000
Printing and Reproduction	559,621	600,000	600,000	650,000	50,000
Other Contractual Services:					
Program Contracts	179,547,253	190,000,000	192,842,000	228,662,000	35,820,000
Program Development and Management Contract Services	3,644,224	4,350,000	3,387,000	3,905,000	518,000
Supplies and Materials	743,472	700,000	700,000	750,000	50,000
Equipment	1,087,736	1,418,000	925,000	925,000	—0—
Grants, Subsidies and Contributions:					
Program Grants	731,860,123	802,487,000	805,892,925	956,038,000	150,145,075
Program Development and Management Grants	4,148	55,000	30,000	30,000	—0—
Subtotal, Research and Related Activities	974,589,717	1,055,568,000	1,064,047,329	1,250,700,000	186,652,671
Science and Engineering Education Activities					
Program Contracts	1,253,860	500,000	2,000,000	3,000,000	1,000,000
Program Grants	19,643,376	14,500,000	28,000,000	36,000,000	8,000,000
Subtotal, Science and Engineering Educatiсn Activities	20,897,236	15,000,000	30,000,000	39,000,000	9,000,000
Special Foreign Currency					
Travel and Transportation of Persons	93,774	100,000	100,000	100,000	—0—
Program Contracts	455,299	600,000	400,000	325,000	-75,000
Program Grants	3,105,629	1,500,000	2,618,067	2,175,000	-443,067
Subtotal, Special Foreign Currency	3,654,702	2,200,000	3,118,067	2,600,000	-518,067
Total, NSF	**$999,141,655**	**$1,072,768,000**	**$1,097,165,396**	**$1,292,300,000**	**$195,134,604**

NATIONAL SCIENCE FOUNDATION

Research and Related Activities

For necessary expenses in carrying out the purposes of the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), title IX of the National Defense Education Act of 1958, (42 U.S.C. 1876-1879) , and the Act to establish a National Medal of Science (42 U.S.C. 1880-1881); services as authorized by 5 U.S.C. 3109; [lease of one aircraft with option to purchase and purchase;] maintenance and operation of aircraft and purchase of flight services for research support; hire of passenger motor vehicles; not to exceed $2,500 for official reception and representation expenses; not to exceed [$62, 381, 000] *$66,000,000* for program development and management; uniforms or allowances therefor, as authorized by law (5 U.S.C. 5901-5902); rental of conference rooms in the District of Columbia; and reimbursement of the General Services Administration for security guard services, [$1, 060,000,000] *$1,250,700,000* to remain available until September 30, [1984] *1985: Provided*, That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation: *Provided further*, That to the extent that the amount appropriated is less than the total amount authorized to be appropriated for included program activities, all amounts, including floors and ceilings, specified in the authorizing Act for those program activities or their subactivities shall be reduced proportionally: [*Provided further*, That of the funds appropriated in this Act or funds appropriated previously to the Foundation, not less than $9,000,000 shall be available for the United States Antarctic Research Program and not more than $73,400,000 shall be available for the United States Antarctic Program operations and support: *Provided further*, That no funds appropriated in this Act or in funds previously appropriated to the Foundation shall be available for the advanced ocean drilling program without the approval of the Committees on Appropriations and not in excess of $12,000,000 shall be available for the deep sea drilling project without the approval of the Committees on Appropriations]. *(Department of Housing and Urban Development- Independent Agencies Appropriation Act, 1983; additional authorizing legislation to be proposed.)*

Scientific Activities Overseas (Special Foreign Currency Program)

For payments in foreign currencies which the Treasury Department determines to be in excess to the normal requirements of the United States, for scientific activities, as authorized by law, [$2,200,000] *$2,600,000*,to remain available until September 30, [1984] *1985: Provided*:That this appropriation shall be available in addition to other appropriations to the National Science Foundation, for payments in the foregoing currencies. *(Department of Housing and Urban Development-Independent Agencies Appropriation Act, 1983; additional authorizing legislation to be proposed.)*

Science *and Engineering* Education Activities

For necessary expenses in carrying out science education programs and activities pursuant to the purposes of the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including award of graduate fellowships, services as authorized by 5 U.S.C. 3109, and rental of conference rooms in the District of Columbia, [$30,000,000] *$39,000,000*, to remain available until September 30, [1984] *1985: Provided*, That to the extent that the amount of this appropriation is less than the total amount authorized to be appropriated for included program activities, all amounts, including floors and ceilings, specified in the authorizing Act for those program activities or their subactivities shall be reduced proportionally. *(Department of Housing and Urban Development - Independent Agencies Appropriations Act, 1983; additional authorizing legislation to be proposed.)*

XIII. Minority Views on National Science Foundation Authorization Bill

For the third year in a row a majority of the Republican Members of the Science and Technology Committee find it necessary to oppose the Committee's budget level for the National Science Foundation. In previous years, our position put us in the role of seeking a reduction in the Committee's R&D budget proposal. However, our support for the strongest and most realistic R&D budget has been in doubt. The NSF fiscal year 1984 budget request clearly reflects that same deep commitment by this Administration, as expressed by President Reagan in the State of the Union Address on January 25, 1983, to keep the United States the technological leader of the world. Considering the current budgetary constraints, it is commendable that this Administration has supported their commitment with an 18-percent increase in the fiscal year 1984 budget request for NSF.

In fiscal year 1984, the proposed level of basic research funding throughout the federal government will include nearly $400 million for purchase and replacement of instrumentation alone. For NSF, this represents a 100-percent increase in funding since 1982 and a 61-percent increase over fiscal year 1983 appropriations. We approve of the logical and realistic step by step approach by NSF to address the problem of research instrumentation in the scientific community.

Therefore we do not dispute the Committee views which state that "* * * it will require a sustained investment over several years to revitalize university laboratories so that they continue to lead the world in scientific research.* * *" However, the Majority's action to add $50 million to the already increased funding is both fiscally irresponsible and counterproductive. Proper management of a problem is not best addressed with a glut of monies, or a "one shot fix-it approach".

In conclusion, the Minority finds a great deal to agree with in the Committee views. However, we feel it necessary to point out our distress with the Majority's action to add in additional monies to an already robust budget request. Their action is particularly disturbing given the strong bipartisan position taken at the subcommittee level to stay at the overall Presidential request of $1,292.3 million.

We continue to support a strong and vibrant scientific enterprise at the National Science Foundation and within the nation's colleges and universities. The Foundation has a strategic role to play in continuing the excellence and superiority of this nation in the field of science and technology. We support that role by favoring the generous budget increase proposed by the Administration. We cannot endorse a higher level of spending in areas already adequately addressed by the budget request.

LARRY WINN, Jr.
MANUEL LUJAN, Jr.
BOB WALKER.
WILLIAM CARNEY.
F. JAMES SENSENBRENNER, Jr.
JUDD GREGG.
RAYMOND J. MCGRATH.
JOE SKEEN.
CLAUDINE SCHNEIDER.
BILL LOWERY.
ROD CHANDLER.
HERBERT H. BATEMAN.
ALFRED A. MCCANDLESS.
TOM LEWIS.

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